CBSE 2023 Science — Set 2 — 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]

Which of the following is an example of endothermic process?

(a) Formation of slaked lime

(b) Decomposition of vegetable matter into compost

(c) Dissolution of ammonium chloride in water <<

(d) Digestion of food in our body

Explanation:

Dissolution of ammonium chloride (NH_4Cl) in water is an endothermic process.

The solution cools down when NH_4Cl dissolves because it absorbs heat from the surroundings.

Formation of slaked lime and digestion are exothermic processes.

Q.2 [1 mark]

In the given experimental set-up, if the experiment is carried out separately with each of the following solutions the cases in which the bulb will glow is/are:

(i) Dilute hydrochloric acid

(ii) Dilute sulphuric acid

(iii) Glucose solution

(iv) Alcohol

(a) (i) only

(b) (ii) only

(c) (i) and (ii) <<

(d) (ii), (iii) and (iv)

Explanation:

The bulb glows when the solution conducts electricity, i.e., when it contains free ions.

Dilute HCl and dilute H_2SO_4 are strong electrolytes that dissociate completely into ions, so the bulb glows with both.

Glucose solution and alcohol are non-electrolytes and do not produce ions.

Hence (i) and (ii) is the correct answer.

Q.3 [1 mark]

In order to balance the following chemical equation, the values of the coefficients x and y respectively are:

x $Pb(NO_3)_2$ —Heat→ 2 PbO + y NO_2 + O_2

(a) 2, 4 <<

(b) 2, 2

(c) 2, 3

(d) 4, 2

Explanation:

Balancing the equation: 2 $Pb(NO_3)_2$ —Heat→ 2 PbO + 4 NO_2 + O_2.

Checking: Pb: 2=2 ✓, N: 2×2=4 ✓, O: 2×6=12 on left; 2+4×2+2=12 on right ✓.

So x=2, y=4.

Q.4 [1 mark]

When zinc reacts with sodium hydroxide, the product formed is:

(a) Sodium oxide

(b) Sodium zincate <<

(c) Zinc hydroxide

(d) Zinc oxide

Explanation:

Zinc is an amphoteric metal that reacts with both acids and bases.

When zinc reacts with sodium hydroxide: $Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$.

The product Na_2ZnO_2 is sodium zincate.

Q.5 [1 mark]

Among the following, the metal with lowest density is:

(a) Lithium <<

(b) Lead

(c) Magnesium

(d) Aluminium

Explanation:

Lithium (Li) is the lightest metal with a density of about 0.534 g/cm³.

It is so light that it floats on water.

Magnesium has density 1.74 g/cm³, aluminium 2.7 g/cm³, and lead 11.34 g/cm³.

Q.6 [1 mark]

The number of electrons in the outermost shell of the atom of a non-metal can be:

(a) 1, 2 or 3

(b) 3, 4 or 5

(c) 5, 6 or 7 <<

(d) 5, 6 or 8

Explanation:

Non-metals typically have 5, 6, or 7 electrons in their outermost shell.

They tend to gain electrons to complete their octet.

Elements with 1, 2, or 3 valence electrons are metals, and those with 4 can be metalloids.

Q.7 [1 mark]

The total number of electrons shared in the formation of an ethyne molecule is:

(a) 6

(b) 3

(c) 10 <<

(d) 4

Explanation:

Ethyne is H–C≡C–H.

The C≡C triple bond shares 3 pairs (6 electrons) and the two C–H single bonds share 2 pairs (4 electrons).

Total shared electrons = 6 + 4 = 10.

Q.8 [1 mark]

Sphincter muscles are present at the exit of:

(a) Stomach and small intestine

(b) Stomach and anus <<

(c) Small intestine and large intestine

(d) Oesophagus and stomach

Explanation:

Sphincter muscles are ring-shaped muscles that control the passage of substances. They are present at the exit of the stomach (pyloric sphincter, which controls food movement into the small intestine) and at the anus (anal sphincter, which controls the exit of undigested waste).

Q.9 [1 mark]

In the following diagram, identify the cells through which massive amounts of gaseous exchange takes place for photosynthesis:

[Diagram shows cross-section of a leaf with labels I, II, III, IV pointing to different cell layers]

(a) I

(b) IV

(c) III <<

(d) II

Explanation:

In a leaf cross-section, the spongy mesophyll cells (label III) are the site where massive gaseous exchange occurs for photosynthesis.

These cells have large intercellular spaces that facilitate the exchange of CO_2 and O_2 through stomata.

Q.10 [1 mark]

During vigorous exercise, the occurrence of cramps in the outer muscles of an athlete is due to the conversion of pyruvate to:

(a) Glucose
(b) Ethanol
(c) Lactic acid <<
(d) Lactose

Explanation:
During vigorous exercise, muscles may not get enough oxygen.
In the absence of sufficient oxygen, anaerobic respiration occurs in muscles, converting pyruvate to lactic acid.
The accumulation of lactic acid causes muscle cramps.

Q.11 [1 mark]

Plants that bear unisexual flowers are:

(a) Mustard and Papaya
(b) Hibiscus and Watermelon
(c) Mustard and Hibiscus
(d) Watermelon and Papaya <<

Explanation:
Unisexual flowers contain either male (stamens) or female (pistil) reproductive parts, but not both.
Watermelon and Papaya bear unisexual flowers.
Mustard and Hibiscus bear bisexual flowers (containing both stamens and pistil).

Q.12 [1 mark]

When an 'X' bearing sperm fertilises the egg, the resulting zygote has the following combination of chromosomes:

(a) 44 + XX <<
(b) 44 + XY
(c) 22 + XX
(d) 22 + XY

Explanation:

A human zygote has 46 chromosomes (23 pairs).

When an X-bearing sperm fertilises the egg (which always carries X), the resulting zygote will be 44 autosomes + XX (female).

This is written as 44 + XX.

Q.13 [1 mark]

An object is placed in front of a convex mirror at infinity. According to the New Cartesian Sign Convention, the sign of the focal length and the sign of the image distance in this case are respectively:

(a) +, –

(b) –, +

(c) –, –

(d) +, + <<

Explanation:

For a convex mirror, the focal point is behind the mirror (virtual), so the focal length is positive (+ve) by New Cartesian Sign Convention.

When an object is at infinity, the image is formed at the focus behind the mirror, so the image distance is also positive (+ve).

Hence both signs are +, +.

Q.14 [1 mark]

For verifying Ohm's law, we design an electric circuit diagram in which we show the arrangement of different circuit components. We find that with respect to the resistor, the:

(a) ammeter is connected in parallel and the voltmeter in series.

(b) ammeter is connected in series and the voltmeter in parallel. <<

(c) ammeter and voltmeter are both connected in series.

(d) ammeter and voltmeter are both connected in parallel.

Explanation:

To verify Ohm's law, the ammeter must be connected in series with the resistor to

measure the current flowing through it, and the voltmeter must be connected in parallel across the resistor to measure the potential difference across it.

Q.15 [1 mark]

In a resistive circuit if the current is increased to two times, the percentage change in the amount of heat dissipated in the circuit would be:

(a) 400%

(b) 300% <<

(c) 200%

(d) 100%

Explanation:

Heat dissipated $H = I^2Rt$.

If current is doubled (2I), new heat = $(2I)^2Rt = 4I^2Rt = 4H$.

The change in heat = $4H - H = 3H$.

Percentage change = $(3H/H) \times 100 = 300\%$.

Q.16 [1 mark]

A positron enters a uniform magnetic field at right angles to it as shown. The direction of force experienced by the positron will be:

[Diagram shows the positron moving upward and the magnetic field pointing to the right]

(a) to the right

(b) to the left

(c) into the page <<

(d) out of the page

Explanation:

The positron is positively charged, so the current is along its velocity (upward).

The field points to the right.

By Fleming's left-hand rule ($F = qv \times B$, $\hat{y} \times \hat{x} = -\hat{z}$) the force is into the page.

Q.17 [1 mark]

Assertion (A): Sodium oxide is an amphoteric oxide.

Reason (R): Metal oxides which react with both acids as well as bases are known as amphoteric oxides.

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

Explanation:

Sodium oxide (Na_2O) is a basic oxide, not an amphoteric oxide.
It reacts only with acids, not with bases.
So Assertion (A) is false.
Reason (R) is true — amphoteric oxides do react with both acids and bases (e.g., Al_2O_3, ZnO).
Hence (d) is correct.

Q.18 [1 mark]

Assertion (A): When a bacterium divides into two, and the resultant two bacteria divide again, the four bacteria produced would be almost similar.
Reason (R): DNA copying involves small inaccuracies in the reproduction process.

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

Explanation:

Both statements are true.
Bacteria produced by binary fission are almost similar (not identical) because DNA copying is not perfectly accurate.

However, the Reason does not correctly explain the Assertion — the reason they are 'almost similar' is because DNA copying is mostly accurate with only minor variations, not because of inaccuracies per se.
The reason explains why they are NOT identical, not why they are similar.
Note: this answer could not be confirmed against an official CBSE marking scheme.

Q.19 [1 mark]

Assertion (A): A person suffering from myopia cannot see the distant objects clearly.
Reason (R): A converging lens is used for the correction of myopic eye as it can form real as well as virtual images of the objects placed in front of it.

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

Explanation:
Assertion (A) is true — myopia (near-sightedness) means distant objects cannot be seen clearly.
Reason (R) is false — a diverging (concave) lens is used to correct myopia, not a converging lens.
A concave lens diverges the light rays so that the image falls on the retina.

Q.20 [1 mark]

Assertion (A): Magnetic field lines do not intersect each other.
Reason (R): Magnetic field lines are imaginary lines, the tangent to which at any point gives the direction of the field at that point.

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

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

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

Explanation:

Both A and R are true.

Magnetic field lines never intersect because at the point of intersection there would be two tangents, meaning two directions of the magnetic field at one point, which is impossible.

However, R does not explain why they don't intersect — it only defines what field lines represent.

So R is not the correct explanation of A.

Section B

Very Short Answer Questions (2 marks each)

Q.21 [2 marks]

(a) What is observed when aqueous solutions of potassium iodide and lead nitrate are mixed together? Name the type of reaction and write the chemical equation for the reaction that occurs.

Answer: When aqueous solutions of potassium iodide (KI) and lead nitrate ($Pb(NO_3)_2$) are mixed, a yellow precipitate of lead iodide (PbI_2) is formed. This is a double displacement reaction (precipitation reaction).

Chemical equation: $Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s)\downarrow + 2KNO_3(aq)$

Explanation:

This is a classic double displacement reaction where the cations and anions of two compounds exchange partners.

The yellow precipitate of PbI_2 confirms the reaction.

OR

Q.21 [2 marks]

OR: When copper powder is heated in a watch glass, a black substance is formed.

(i) Why is this black substance formed? Name it.

(ii) How can this black substance be reversed to its original form?

Answer: (i) When copper powder is heated, it reacts with oxygen in the air to form copper oxide (CuO), which is a black substance. This is an oxidation reaction: $2Cu + O_2 \rightarrow 2CuO$.

(ii) The black copper oxide can be reversed to copper by passing hydrogen gas over it (reduction): $CuO + H_2 \rightarrow Cu + H_2O$. This is a reduction reaction where CuO is reduced back to copper.

Explanation:

Heating copper in air causes oxidation forming black CuO.

This can be reversed by reduction using hydrogen gas.

Q.22 [2 marks]

(a) Why is it important to prevent oxygenated and deoxygenated blood from mixing in birds and mammals?

(b) Which animals can tolerate some mixing of the oxygenated and deoxygenated blood streams? On what factor does the body temperature of these animals depend?

Answer: (a) Birds and mammals have high energy needs as they are warm-blooded (maintain constant body temperature). Separating oxygenated and deoxygenated blood ensures efficient supply of oxygen to the body, which is essential for producing the energy needed to maintain body temperature.

(b) Amphibians and reptiles can tolerate some mixing of oxygenated and deoxygenated blood. Their body temperature depends on the temperature of the environment (they are cold-blooded/ectothermic animals).

Explanation:

Warm-blooded animals need efficient oxygen delivery, hence the four-chambered heart separates the blood.

Cold-blooded animals like amphibians and reptiles have three-chambered hearts allowing some mixing.

Q.23 [2 marks]

Mendel crossed a pure tall pea plant (TT) with a pure short pea plant (tt) and obtained all tall plants in F_1 generation.

(a) What is the gene combination present in the plants of F_1 generation?

(b) Give reason why only tall plants are observed in F_1 progeny.

(c) What will be the ratio of the plants obtained in the F_2 generation when F_1 plants are self-pollinated?

Answer: (a) The gene combination in F_1 plants is Tt (heterozygous tall).

(b) Only tall plants are observed in F_1 because tallness (T) is the dominant trait over shortness (t). In the heterozygous condition (Tt), the dominant allele expresses itself.

(c) When F_1 plants (Tt) are self-pollinated: Tt × Tt gives TT : Tt : tt = 1:2:1 (genotypic ratio). Phenotypic ratio = 3 tall : 1 short (3:1).

Explanation:

This demonstrates Mendel's Law of Dominance and Law of Segregation.

The dominant trait masks the recessive in F_1, and both traits appear in 3:1 ratio in F_2.

Q.24 [2 marks]

(a) When and where does a rainbow appear in the sky? Draw a labelled ray diagram to show its formation.

Answer: A rainbow is seen in the sky after rain (or during rain) when the sun is behind the observer. It appears in the part of the sky opposite to the sun. Rainbow formation involves dispersion of sunlight by water droplets in the atmosphere. The sunlight undergoes refraction, internal reflection, and dispersion inside the water droplet, splitting white light into its seven component colours (VIBGYOR).

Explanation:

A rainbow is formed by dispersion of sunlight through raindrops.

It requires the sun to be behind the observer and rain in front.

OR

Q.24 [2 marks]

OR: (b) What is scattering of light? Why does the clear sky appear blue?

Answer: Scattering of light is the phenomenon in which light is redirected in different directions when it strikes very fine particles. When sunlight enters the atmosphere, it gets scattered by the tiny particles (molecules of air, dust). Blue light has a shorter wavelength compared to red light and is scattered much more (scattering is inversely proportional to the fourth power of wavelength, Rayleigh scattering). This is why the clear sky appears blue — we see the scattered blue light from all directions.

Explanation:

According to Rayleigh's law of scattering, intensity of scattered light is inversely proportional to λ^4.

Blue light (shorter wavelength) is scattered more, making the sky appear blue.

Q.25 [2 marks]

V–I graph for two conducting wires A and B are as shown. If both wires are of the same length and same diameter, which of the two is made of a material of high resistivity? Give reasons to justify your answer.

[Graph shows two straight lines through origin; wire B has steeper slope than wire A]

Answer: From the V–I graph, the slope is V/I = R. Wire B has the steeper line, so B has the greater resistance. Both wires have the same length and diameter (same cross-sectional area A), and R = ρl/A, so the wire with greater resistance has greater resistivity. Hence wire B is made of the material of higher resistivity.

Explanation:

On a V–I graph a steeper line means greater resistance.

With l and A equal, ρ = RA/l is greater for B.

Q.26 [2 marks]

We do not clean ponds or lakes but an aquarium needs to be cleaned regularly. Why?

Answer: Ponds and lakes are natural ecosystems that are self-sustaining. They have decomposers (bacteria, fungi) that break down waste and dead organisms, maintaining the nutrient cycle. They also have a variety of organisms that form a food chain, keeping the ecosystem balanced. An aquarium is an artificial ecosystem that is not self-sustaining. It lacks sufficient decomposers and the variety of organisms needed to maintain balance. Waste products accumulate and are not naturally recycled, so regular cleaning is required.

Explanation:

Natural ecosystems like ponds have self-sustaining decomposition and nutrient cycling, while artificial ecosystems like aquariums lack these mechanisms.

Section C

Short Answer Questions (3 marks each)

Q.27 [3 marks]

Silver chloride kept in a china dish turns grey in sunlight.

(a) Write the colour of silver chloride when it was kept in the china dish.

(b) Name the type of chemical reaction taking place and write the chemical equation for the reaction.

(c) State one use of the reaction. Name one more chemical which can be used for the same purpose.

Answer: (a) Silver chloride (AgCl) is white in colour when freshly prepared.

(b) This is a photolytic decomposition reaction (photo-decomposition). Chemical equation: $2AgCl(s) \xrightarrow{\text{sunlight}} 2Ag(s) + Cl_2(g)$. The white AgCl decomposes into grey silver metal and chlorine gas.

(c) This reaction is used in black-and-white photography. Silver bromide (AgBr) can also be used for the same purpose as it also undergoes similar photolytic decomposition.

Explanation:

AgCl is white and decomposes in sunlight to form grey silver and chlorine gas.

This photodecomposition is used in photography.

AgBr also shows the same property.

Q.28 [3 marks]

With the help of suitable chemical equations, list the two main differences between roasting and calcination. How is metal reduced from the product obtained after roasting/calcination of the ore? Write the chemical equation for the reaction involved.

Answer: Roasting: Heating the ore strongly in the presence of excess air (for sulphide ores).

Example: $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$

Calcination: Heating the ore strongly in limited air or absence of air (for carbonate ores).

Example: $ZnCO_3 \xrightarrow{Heat} ZnO + CO_2$

Differences:

1. Roasting is done for sulphide ores; calcination is done for carbonate ores.
2. In roasting, SO_2 gas is released; in calcination, CO_2 gas is released.

The metal oxide obtained is then reduced to metal using a suitable reducing agent like carbon (coke):

$ZnO + C \rightarrow Zn + CO$

Explanation:

Roasting converts sulphide ores to oxides in excess air, while calcination converts carbonate ores to oxides in limited air.

The resulting metal oxide is reduced using carbon.

Q.29 [3 marks]

(a) (i) What is the first step in the breakdown of glucose during aerobic and anaerobic respiration? Where does it take place?

(ii) ATP is called the energy currency of the cell. Why?

(iii) What is meant by "residual volume of air" in a breathing cycle?

Answer: (a) (i) The first step is glycolysis, in which glucose (6-carbon molecule) is broken down into two molecules of pyruvate (3-carbon each). This occurs in the cytoplasm of the cell. This step is common to both aerobic and anaerobic respiration.

(ii) ATP (Adenosine Triphosphate) is called the energy currency of the cell because it provides energy for all cellular activities. The energy stored in ATP can be used by the cell to drive various biological processes like muscle contraction, nerve impulse transmission, etc. Just as money is used to buy things, ATP is used to power cellular reactions.

(iii) Residual volume of air is the volume of air that remains in the lungs after the most forceful expiration. This air cannot be expelled and ensures that the lungs do not collapse.

Explanation:

Glycolysis is the first step of both aerobic and anaerobic respiration, occurring in the cytoplasm.

ATP stores and releases energy for cellular activities.

OR

Q.29 [3 marks]

OR: (b) Write in sequence the steps for experimental verification of the fact that "sunlight is essential for photosynthesis".

Answer: Steps for the experiment:

1. Take a potted plant and keep it in a dark room for 2-3 days to destarch the leaves.

2. Take one leaf and cover a part of it with black paper (on both sides) using

paper clips.

3. Place the plant in sunlight for 6 hours.

4. Pluck the leaf and remove the black paper.

5. Boil the leaf in water to soften it.

6. Boil the leaf in alcohol (using a water bath) to remove chlorophyll (decolourise it).

7. Wash the leaf with water.

8. Add iodine solution to the leaf.

9. Observation: The uncovered part of the leaf turns blue-black (presence of starch) while the covered part does not change colour (no starch formed).

10. Conclusion: Sunlight is essential for photosynthesis as starch is produced only in the presence of sunlight.

Explanation:

The starch test using iodine after partially covering a destarched leaf proves that photosynthesis requires sunlight.

Q.30 [3 marks]

Name the hormone released and the gland which secretes it in human beings during scary situations. How does the body respond to enable it to deal with the situation?

Answer: The hormone released during scary (stressful) situations is Adrenaline (also called epinephrine). It is secreted by the adrenal glands (located on top of the kidneys).

Body's response:

1. Heart beats faster, increasing blood supply to muscles.

2. Breathing rate increases to supply more oxygen.

3. Blood is diverted from the digestive system to skeletal muscles.

4. The pupils of the eyes dilate.

5. Blood sugar level increases for more energy.

All these changes prepare the body for a 'fight or flight' response.

Explanation:

Adrenaline from adrenal glands triggers the fight-or-flight response: increased heart rate, breathing rate, and blood supply to muscles.

Q.31 [3 marks]

(a) A student has focussed the image of an object of height 3 cm on a white screen using a concave mirror of focal length 12 cm. If the distance of the object from the mirror is 18 cm, find the values of the following:

(i) Distance of the image from the mirror

(ii) Height of the image

Answer: (i) Using mirror formula: 1/v + 1/u = 1/f

Given: f = -12 cm (concave mirror), u = -18 cm (object in front of mirror)

1/v + 1/(-18) = 1/(-12)

1/v = -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).

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

Height of image = m × height of object = -2 × 3 = -6 cm

The image is 6 cm tall and inverted (negative sign indicates inverted image).

Explanation:

Using mirror formula 1/v + 1/u = 1/f with proper sign convention gives v = -36 cm and image height = -6 cm (real, inverted, magnified).

OR

Q.31 [3 marks]

OR: (b) Define power of a lens. The focal length of a lens is -10 cm. Write the nature of the lens and find its power. If an object is placed at a distance of 20 cm from the optical centre of this lens, according to the New Cartesian

Sign Convention, what will be the sign of magnification in this case?

Answer: Power of a lens is defined as the reciprocal of its focal length (in metres). P = 1/f. The SI unit of power is dioptre (D).

Given: f = -10 cm = -0.1 m
Since focal length is negative, the lens is a concave lens (diverging lens).
Power P = 1/f = 1/(-0.1) = -10 D

For a concave lens, the image formed is always virtual, erect, and diminished for all object positions.
Using lens formula: 1/v - 1/u = 1/f
u = -20 cm, f = -10 cm
1/v = 1/f + 1/u = 1/(-10) + 1/(-20) = (-2-1)/20 = -3/20
v = -20/3 = -6.67 cm
Magnification m = v/u = (-6.67)/(-20) = +1/3
The sign of magnification is positive (+), indicating the image is erect and virtual.

Explanation:
Concave lens with f = -10 cm has power -10 D.
Image is virtual, erect (positive magnification) and diminished.

Q.32 [3 marks]

Explain the meaning of overloading of an electrical circuit. List two possible causes due to which overloading may occur in household circuits. Write one preventive measure that should be taken to avoid overloading of domestic circuits.

Answer: Overloading means drawing more current from the mains supply than the circuit is designed to carry. When too many appliances are connected to a single circuit or when high-power appliances are used, the current exceeds the safe limit, causing excessive heating of wires.

Two causes of overloading:

1. Connecting too many appliances to a single socket (multiple plug usage).

2. Using appliances of higher power rating than the circuit is designed for, or accidental increase in voltage.

Preventive measure: Use an electric fuse of appropriate rating in the circuit. The fuse wire melts and breaks the circuit when current exceeds the safe limit, preventing damage. Also, using separate circuits for heavy appliances helps prevent overloading.

Explanation:

Overloading occurs when current exceeds the circuit's capacity due to too many appliances or high-power devices.

Fuses protect against overloading.

Q.33 [3 marks]

Explain how some harmful chemicals enter our bodies through the food chain. Why is the concentration of these harmful chemicals found to be maximum in human beings?

Answer: Harmful chemicals like pesticides (DDT), heavy metals, etc. enter the food chain through the following process:

1. These chemicals are sprayed on crops or released into water bodies.

2. Plants/algae absorb these chemicals from soil/water.

3. When herbivores eat the plants, these chemicals enter their bodies and accumulate in their tissues.

4. When carnivores eat the herbivores, the chemicals further concentrate in their bodies.

This process is called biological magnification (biomagnification). At each trophic level, the concentration of these non-biodegradable chemicals increases because:

- These chemicals cannot be decomposed or excreted easily.

- They accumulate in fatty tissues.
- Organisms at higher trophic levels consume large quantities of organisms from lower levels.

Human beings are at the top of most food chains, so the concentration of harmful chemicals is maximum in them.

Explanation:

Biological magnification causes non-biodegradable chemicals to accumulate at higher trophic levels.

Humans, being at the top of the food chain, have the highest concentration.

Section D

Long Answer Questions (5 marks each)

Q.34 [5 marks]

(a) An acid 'X' and an alcohol 'Y' react with each other in the presence of an acid catalyst to form a sweet smelling substance 'Z'. Identify 'X', 'Y' and 'Z'. Write the chemical equation for the reaction involved and name it. The substance 'Z' on treatment with sodium hydroxide produces back the alcohol 'Y' and sodium ethanoate. Write the chemical equation for the reaction involved and name it, giving justification for the name.

Answer: X = Ethanoic acid (acetic acid, CH_3COOH)

Y = Ethanol (C_2H_5OH)

Z = Ester (Ethyl ethanoate / Ethyl acetate, $CH_3COOC_2H_5$)

Esterification reaction:

$CH_3COOH + C_2H_5OH \xrightarrow{\text{(acid catalyst)}} CH_3COOC_2H_5 + H_2O$

(Ethanoic acid + Ethanol → Ethyl ethanoate + Water)

This reaction is called esterification.

Saponification reaction:

$CH_3COOC_2H_5 + NaOH \rightarrow CH_3COONa + C_2H_5OH$

(Ethyl ethanoate + Sodium hydroxide → Sodium ethanoate + Ethanol)

This reaction is called saponification because this is the same type of reaction used in making soap (sapon = soap in Latin). When esters or fats react with a base (like NaOH), it is called saponification.

Explanation:

Esterification produces sweet-smelling esters from acids and alcohols.

The reverse reaction with NaOH is saponification.

OR

Q.34 [5 marks]

OR: (b)

(i) Name the simplest saturated hydrocarbon. Draw its electron dot structure. Which type of bonds exist in this compound?

(ii) Name any two mixtures of the carbon compound used as a fuel in daily life, of which the above mentioned compound is an important component.

(iii) In which homologous series of carbon compounds can this compound be placed? Write the general formula of the series.

(iv) Which type of flame is produced on burning it?

Answer: (i) The simplest saturated hydrocarbon is Methane (CH_4). In its electron dot structure, the carbon atom shares one pair of electrons with each of the four hydrogen atoms, forming four single covalent bonds. Only single bonds (covalent bonds) exist in this compound.

(ii) Two mixtures: CNG (Compressed Natural Gas) and Biogas/Gobar gas. Methane is the major component of both.

(iii) Methane belongs to the alkane homologous series. The general formula is C_nH_{2n+2}.

(iv) Methane produces a clean blue flame on burning (complete combustion) as it is a simple hydrocarbon with low carbon content.

Explanation:

Methane (CH_4) is the simplest alkane with single covalent bonds.

It is a major component of CNG and biogas, and burns with a blue flame.

Q.35 [5 marks]

(a)

(i) List three points of difference between nervous and hormonal mechanisms for control and coordination in animals.

(ii) How are auxins related with the bending of plant shoot towards unidirectional light? Explain.

Answer: (a)(i) Differences between nervous and hormonal mechanisms:

1. Nervous mechanism uses electrical impulses for transmission; hormonal mechanism uses chemical substances (hormones) through blood.
2. Nervous response is very fast (within milliseconds); hormonal response is slow (may take minutes to hours).
3. Nervous response is short-lived and precise; hormonal response is long-lasting and widespread.
4. Nervous mechanism involves neurons; hormonal mechanism involves endocrine glands.
5. Nervous mechanism transmits through nerve fibres; hormonal mechanism transmits through blood.

(a)(ii) When light falls on one side of a plant shoot:

- Auxin hormone accumulates on the shaded side (away from light).
- Higher concentration of auxin on the shaded side causes the cells on that side to elongate more.
- The cells on the illuminated side elongate less due to lower auxin concentration.
- This differential growth causes the shoot to bend towards the light (positive

phototropism).

Explanation:

Nervous mechanism is fast, electrical, and short-lived while hormonal mechanism is slow, chemical, and long-lasting.

Auxins cause phototropism by differential growth.

OR

Q.35 [5 marks]

OR: (b)

(i) Name the disorder that a person is likely to suffer from due to the following:

(I) Over-secretion of growth hormone

(II) Deficiency of oestrogen in females

(III) Less secretion of thyroxine

Also name the gland that secretes each of the hormones mentioned above.

(ii) How is the timing and amount of hormone released regulated? Explain with the help of an example.

Answer: (b)(i)

(I) Over-secretion of growth hormone causes Gigantism (in children) or Acromegaly (in adults). Growth hormone is secreted by the Pituitary gland.

(II) Deficiency of oestrogen in females leads to Osteoporosis (weak bones) and disruption of the menstrual cycle. Oestrogen is secreted by the Ovaries.

(III) Less secretion of thyroxine causes Goitre (enlarged thyroid) or Hypothyroidism (reduced metabolic rate). Thyroxine is secreted by the Thyroid gland.

(b)(ii) The timing and amount of hormone released is regulated by a feedback mechanism. For example:

- When blood sugar level rises (after eating), the pancreas secretes insulin which lowers blood sugar by converting glucose to glycogen.
- When blood sugar level falls, the pancreas reduces insulin secretion.

- If blood sugar drops too low, glucagon is secreted to convert glycogen back to glucose.

This is a negative feedback mechanism that maintains homeostasis.

Explanation:

Hormonal disorders arise from over/under-secretion.

Feedback mechanisms regulate hormone levels, as seen in insulin-blood sugar regulation.

Q.36 [5 marks]

(a) An object is placed in front of a convex lens of focal length f. If the distance of the object from the lens is 2f, draw a ray diagram to show the formation of the image. Write the value of magnification in this case.

(b) A student has focussed the image of a candle flame on a white screen using a convex lens. The situation is as given below:

Length of the flame = 2 cm

Focal length of the lens = 12 cm

Distance of the flame from the lens = 16 cm

If the flame is perpendicular to the principal axis of the lens, calculate the values of the following:

(i) Distance of the image from the lens

(ii) Length of the image formed

Answer: (a) When object is at 2f: Image is formed at 2f on the other side, real, inverted, and same size as object. Magnification m = -1 (negative sign indicates inverted image, magnitude 1 indicates same size).

(b) Given: h_1 = 2 cm, f = +12 cm, u = -16 cm

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

1/v - 1/(-16) = 1/12

1/v + 1/16 = 1/12

1/v = 1/12 - 1/16 = (4-3)/48 = 1/48

v = +48 cm

(i) Distance of image from the lens = 48 cm (on the other side, real image).

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

Length of image = |m| × h_1 = 3 × 2 = 6 cm

The image is 6 cm tall, real and inverted.

Explanation:

At 2f, image is same size and inverted (m=-1).

For the candle problem, using lens formula gives v=48cm and image height=6cm (inverted).

Q.37(a) [4 marks]

Case Study: The teacher while conducting practicals in the laboratory divided the students into three groups and gave them various solutions to find out their pH and classify them into acidic, basic and neutral solutions.

Group A - Lemon juice, vinegar, colourless aerated drink

Group B - Tomato juice, coffee, ginger juice

Group C - Sodium hydroxide, sodium chloride, lime water

(a) For the solutions provided, which group is/are likely to have pH (i) less than 7, and (ii) greater than 7?

(a) (i) Groups A and B; (ii) Group C <<

(b) (i) Group A only; (ii) Groups B and C

(c) (i) Group C only; (ii) Groups A and B

(d) (i) Groups A, B and C; (ii) none

Explanation:

Group A (lemon juice, vinegar, aerated drink) and Group B (tomato juice, coffee, ginger juice) are acidic, so pH < 7.

In Group C, NaOH and lime water are basic (pH > 7); NaCl is neutral (pH = 7).

Q.37(b) [4 marks]

Case Study: The teacher while conducting practicals in the laboratory divided the students into three groups and gave them various solutions to find out their pH.

Group A - Lemon juice, vinegar, colourless aerated drink

Group B - Tomato juice, coffee, ginger juice

Group C - Sodium hydroxide, sodium chloride, lime water

(b) List two ways of determining pH of a solution.

Answer: Two ways of determining pH of a solution:

1. Using pH paper (universal indicator paper) — dip the pH paper in the solution and compare the colour change with the pH colour chart.

2. Using a pH meter — an electronic device that gives accurate pH readings when its electrode is dipped in the solution.

Other methods include using litmus paper or liquid indicators like phenolphthalein and methyl orange.

Explanation:

pH can be determined using pH paper (colour comparison) or a pH meter (electronic measurement).

Q.37(c) [4 marks]

Case Study: pH in daily life.

(c) Explain, why the sour substances such as lemon juice are effective in cleaning the tarnished copper vessels.

Answer: Copper vessels get tarnished due to the formation of a green layer of basic copper carbonate [$CuCO_3.Cu(OH)_2$] on the surface when copper reacts with moist air containing CO_2. Lemon juice contains citric acid, which is acidic in nature. When lemon juice is applied to tarnished copper vessels, the acid reacts with and dissolves the basic copper carbonate layer, thereby cleaning the surface and restoring the shine of copper.

Explanation:

Citric acid in lemon juice dissolves the basic copper carbonate tarnish on copper vessels through an acid-base reaction.

OR

Q.37(c) [4 marks]

OR: (c) "pH has great importance in our daily life." Justify this statement by giving two examples.

Answer: pH has great importance in our daily life:

1. Our stomach produces hydrochloric acid (pH ~ 1.2) which helps in digestion. When excess acid is produced, it causes acidity/indigestion. Antacids (mild bases like $Mg(OH)_2$) are taken to neutralize the excess acid and provide relief.

2. Tooth decay: Bacteria in the mouth produce acids by degrading sugar and food particles. When the pH in the mouth falls below 5.5, tooth enamel (calcium phosphate) starts to corrode. Using toothpaste (which is basic) helps neutralize the acid and prevents tooth decay.

3. Bee stings inject formic acid (methanoic acid). Applying baking soda (mild base) neutralizes the acid and provides relief.

4. Soil pH affects plant growth — different plants need different pH ranges for optimal growth.

Explanation:

pH is important in digestion (stomach acid), dental health (acid causes tooth decay), treating stings, and agriculture (soil pH).

Q.38(a) [4 marks]

Case Study: All the reproductive methods of living organisms are broadly categorized into two types: 1. Asexual reproduction, and 2. Sexual reproduction. Asexual reproduction involves the participation of a single parent without the formation of gametes, fertilisation and transfer of genetic material. This method is a common means of rapidly increasing offsprings under favourable conditions.

(a) Name the type of fission that occurs in Leishmania and Plasmodium.

(a) Binary fission in both
(b) Multiple fission in both
(c) Binary fission in Leishmania; Multiple fission in Plasmodium <<
(d) Multiple fission in Leishmania; Binary fission in Plasmodium

Explanation:
Leishmania reproduces by binary fission (the cell divides into two) but in a definite orientation (longitudinal binary fission).
Plasmodium reproduces by multiple fission where the parent cell divides into many daughter cells simultaneously.

Q.38(b) [4 marks]

Case Study: Asexual reproduction involves the participation of a single parent without the formation of gametes.

(b) Write one advantage of sexual mode of reproduction over asexual reproduction.

Answer: Sexual reproduction produces variations in the offspring because it involves the fusion of gametes from two different parents, combining different sets of genes. These variations are important for the survival of species and enable adaptation to changing environments. In contrast, asexual reproduction produces offspring that are genetically identical (clones) with no or minimal variation.

Explanation:
Sexual reproduction creates genetic variation through the combination of genes from two parents, enabling better adaptation and evolution.

Q.38(c) [4 marks]

Case Study: Asexual reproduction is a common means of rapidly increasing offsprings under favourable conditions.

(c) Give reasons why:

(i) Colonies of yeast fail to multiply in water but multiply in sugar solution.

(ii) Rhizopus individuals do not grow on a dry slice of bread.

Answer: (i) Yeast requires nutrients (especially sugar/carbohydrates) as a source of energy for growth and reproduction (budding). Water alone does not provide the nutrients needed. In sugar solution, yeast gets the nutrition required and can multiply by budding.

(ii) Rhizopus (bread mould) requires moisture for growth. A dry slice of bread does not provide the moisture needed for the spores of Rhizopus to germinate and grow. Rhizopus grows well on moist/damp bread as moisture is essential for its growth and reproduction.

Explanation:

Yeast needs sugar as nutrition for budding.

Rhizopus needs moisture for its spores to germinate and grow.

OR

Q.38(c) [4 marks]

OR: (c) Name the filamentous structures a student could identify when he collected water from a pond that appeared dark green. How do these organisms multiply? Explain.

Answer: The filamentous structures are Spirogyra (green algae). Spirogyra multiplies by a process called fragmentation. In this process:

1. The filament of Spirogyra breaks into two or more fragments.

2. Each fragment then grows into a new individual by cell division.

3. This is possible because Spirogyra is a simple multicellular organism where each cell is capable of growing into a complete organism.

Spirogyra can also reproduce sexually by conjugation.

Explanation:

Spirogyra is a filamentous green alga found in ponds.

It reproduces asexually by fragmentation where each fragment grows into a new

organism.

Q.39(a) [4 marks]

Case Study: Consider the following electrical circuit diagram in which nine identical resistors of 3 Ω each are connected as shown. If the reading of the ammeter A_1 is 1 ampere, answer the following:

[Circuit: three groups in series. Group 1 has two 3 Ω resistors in parallel (voltmeter V_1 across it); group 2 has three in parallel (V_2 across it); group 3 has three in parallel, with ammeter A_2 in series with one of them. A_1 and A_3 are in the main line.]

(a) What is the relationship between the readings of A_1 and A_3? Give reasons for your answer.

Answer: The readings of A_1 and A_3 are equal, i.e., $A_1 = A_3 = 1$ A.

Reason: A_1 and A_3 are connected in the main line of the series circuit. In a series circuit, the current remains the same throughout. Since the three groups of parallel resistors are connected in series, the same current flows through A_1 and A_3.

Explanation:

In a series circuit, current is the same at all points.

A_1 and A_3 are both in the main series loop, so they read the same current (1 A).

Q.39(b) [4 marks]

Case Study: Electrical circuit with nine identical 3 Ω resistors. A_1 reads 1 ampere.

(b) What is the relationship between the readings of A_2 and A_3?

Answer: A_2 reads one-third of A_3, i.e., $A_2 = A_3/3$.

$A_3 = 1$ A (same as A_1, in the main line).

A_2 is connected across one of the three parallel resistors in the last group. Since the three 3Ω resistors in that group are identical and in parallel, the current divides

equally among them. So A_2 = 1/3 A.

Therefore $A_2 = A_3/3$.

Explanation:

A_3 carries the total current (1A) while A_2 carries current through one of three identical parallel branches, so A_2 = 1/3 A.

Q.39(c) [4 marks]

Case Study: Electrical circuit with nine identical 3 Ω resistors. A_1 reads 1 ampere.

(c) Determine the reading of the voltmeter V_1.

Answer: Group 1 (across which V_1 is connected) has two 3 Ω resistors in parallel:

1/R = 1/3 + 1/3 = 2/3, so R = 1.5 Ω

Current through the group = 1 A (series circuit)

$V_1 = I \times R = 1 \times 1.5 = 1.5$ V

Explanation:

V_1 is across two 3 Ω resistors in parallel (1.5 Ω); V = 1 × 1.5 = 1.5 V.

OR

Q.39(c) [4 marks]

OR: (c) Find the total resistance of the circuit.

Answer: Group 1 (two 3 Ω in parallel): $1/R_1 = 2/3$, R_1 = 1.5 Ω

Group 2 (three 3 Ω in parallel): R_2 = 1 Ω

Group 3 (three 3 Ω in parallel): R_3 = 1 Ω

The groups are in series, so total resistance = 1.5 + 1 + 1 = 3.5 Ω

Explanation:

Group 1 = 1.5 Ω, group 2 = 1 Ω, group 3 = 1 Ω; in series the total is 3.5 Ω.