CBSE 2024 Science — Set 1 — 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]

When 2 mL of sodium hydroxide solution is added to few pieces of granulated zinc in a test tube and then warmed, the reaction that occurs can be written in the form of a balanced chemical equation as:

(a) $NaOH + Zn \rightarrow NaZnO_2 + H_2O$

(b) $2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2$ <<

(c) $2NaOH + Zn \rightarrow NaZnO_2 + H_2$

(d) $2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2O$

Explanation:

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

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

With NaOH, it forms sodium zincate and hydrogen gas is evolved.

Q.2 [1 mark]

Select from the following a decomposition reaction in which source of energy for decomposition is light:

(a) $2FeSO_4 \rightarrow Fe_2O_3 + SO_2 + SO_3$

(b) $2H_2O \rightarrow 2H_2 + O_2$

(c) $2AgBr \rightarrow 2Ag + Br_2$ <<

(d) $CaCO_3 \rightarrow CaO + CO_2$

Explanation:

Silver bromide (AgBr) decomposes in the presence of sunlight into silver and bromine: $2AgBr \rightarrow^{(sunlight)} 2Ag + Br_2$.

This is a photolytic decomposition reaction.

$FeSO_4$ decomposes by heat, H_2O by electricity, and $CaCO_3$ by heat.

Q.3 [1 mark]

A metal and a non-metal that exists in liquid state at the room temperature

are respectively:

(a) Bromine and Mercury
(b) Mercury and Iodine
(c) Mercury and Bromine <<
(d) Iodine and Mercury

Explanation:

Mercury is the only metal that exists in liquid state at room temperature.
Bromine is the only non-metal that exists in liquid state at room temperature.
So the correct answer is Mercury (metal) and Bromine (non-metal).

Q.4 [1 mark]

Carbon compounds:
(i) are good conductors of electricity.
(ii) are bad conductors of electricity.
(iii) have strong forces of attraction between their molecules.
(iv) have weak forces of attraction between their molecules.
The correct statements are:

(a) (i) and (ii)
(b) (ii) and (iii)
(c) (ii) and (iv) <<
(d) (i) and (iii)

Explanation:

Carbon compounds (covalent compounds) are bad conductors of electricity because they do not have free electrons or ions.
They also have weak intermolecular forces of attraction (van der Waals forces), which is why they generally have low melting and boiling points.
Hence (ii) and (iv) are correct.

Q.5 [1 mark]

Consider the following compounds:
$FeSO_4$; $CuSO_4$; $CaSO_4$; Na_2CO_3

The compound having maximum number of water of crystallisation in its crystalline form in one molecule is:

(a) $FeSO_4$
(b) $CuSO_4$
(c) $CaSO_4$
(d) Na_2CO_3 <<

Explanation:

The water of crystallisation for each compound: $FeSO_4 \cdot 7H_2O$ (7 molecules), $CuSO_4 \cdot 5H_2O$ (5 molecules), $CaSO_4 \cdot 2H_2O$ (2 molecules), $Na_2CO_3 \cdot 10H_2O$ (10 molecules).

Na_2CO_3 (washing soda) has the maximum number of water of crystallisation — 10 molecules per formula unit.

Q.6 [1 mark]

Oxides of aluminium and zinc are:

(a) acidic
(b) basic
(c) amphoteric <<
(d) neutral

Explanation:

Aluminium oxide (Al_2O_3) and zinc oxide (ZnO) are amphoteric oxides.

They react with both acids and bases.

For example, Al_2O_3 reacts with HCl (acid) and NaOH (base), and similarly ZnO reacts with both acids and bases.

Q.7 [1 mark]

$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

The reaction given above is a redox reaction because in this case:

(a) MnO_2 is oxidised and HCl is reduced.
(b) HCl is oxidised.
(c) MnO_2 is reduced.

(d) MnO_2 is reduced and HCl is oxidised. <<

Explanation:

In this reaction, MnO_2 is reduced (Mn goes from +4 to +2 oxidation state) and HCl is oxidised (Cl goes from -1 to 0 in Cl_2).

This is a redox reaction because both oxidation and reduction occur simultaneously.

Q.8 [1 mark]

Consider the following statements:

(i) The sex of a child is determined by what it inherits from the mother.

(ii) The sex of a child is determined by what it inherits from the father.

(iii) The probability of having a male child is more than that of a female child.

(iv) The sex of a child is determined at the time of fertilisation when male and female gametes fuse to form a zygote.

The correct statements are:

(a) (i) and (iii)

(b) (ii) and (iv) <<

(c) (iii) and (iv)

(d) (i), (iii) and (iv)

Explanation:

The sex of a child is determined by the father's chromosome contribution.

If the sperm carries X chromosome, the child is female (XX);

if it carries Y chromosome, the child is male (XY).

This determination happens at the time of fertilisation when gametes fuse to form a zygote.

So statements (ii) and (iv) are correct.

Q.9 [1 mark]

Chromosomes:

(i) carry hereditary information from parents to the next generation.

(ii) are thread like structures located inside the nucleus of an animal cell.

(iii) always exist in pairs in human reproductive cells.

(iv) are involved in the process of cell division.

The correct statements are:

(a) (i) and (ii)

(b) (iii) and (iv)

(c) (i), (ii) and (iv) <<

(d) (i) and (iv)

Explanation:

Chromosomes carry hereditary information (DNA) from parents to offspring (i - correct).

They are thread-like structures in the nucleus (ii - correct).

In human reproductive cells (gametes), chromosomes are haploid (23, not in pairs), so (iii) is incorrect.

Chromosomes are involved in cell division (iv - correct).

So (i), (ii) and (iv) are correct.

Q.10 [1 mark]

In a nerve cell, the site where the electrical impulse is converted into a chemical signal is known as:

(a) Axon <<

(b) Dendrites

(c) Neuromuscular junction

(d) Cell body

Explanation:

At the axon terminal (synaptic knob), the electrical impulse is converted into a chemical signal.

The axon terminal releases neurotransmitters (chemical signals) into the synaptic cleft to transmit the signal to the next neuron or effector organ.

Q.11 [1 mark]

A stomata closes when:

(i) it needs carbon dioxide for photosynthesis.

(ii) it does not need carbon dioxide for photosynthesis.
(iii) water flows out of the guard cells.
(iv) water flows into the guard cells.
The correct reason(s) in this process is/are:

(a) (i) only
(b) (i) and (iii)
(c) (ii) and (iii) <<
(d) (ii) and (iv)

Explanation:
Stomata close when: (1) the plant does not need CO_2 for photosynthesis (e.g., at night), and (2) when water flows out of the guard cells, making them flaccid and causing the stomatal pore to close.
So statements (ii) and (iii) are correct.

Q.12 [1 mark]

At what distance from a convex lens should an object be placed to get an image of the same size as that of the object on a screen?

(a) Beyond twice the focal length of the lens.
(b) At the principal focus of the lens.
(c) At twice the focal length of the lens. <<
(d) Between the optical centre of the lens and its principal focus.

Explanation:
When an object is placed at 2F (twice the focal length or at the centre of curvature) of a convex lens, the image formed is of the same size as the object, real, inverted, and located at 2F on the other side of the lens.

Q.13 [1 mark]

The lens system of human eye forms an image on a light sensitive screen, which is called as:

(a) Cornea
(b) Ciliary muscles

(c) Optic nerves

(d) Retina <<

Explanation:

The retina is the light-sensitive screen at the back of the eye where the image is formed by the lens system.

It contains photoreceptor cells (rods and cones) that convert light into electrical signals sent to the brain via the optic nerve.

Q.14 [1 mark]

The pattern of the magnetic field produced inside a current carrying solenoid is: (Options show diagrams)

(a) Parallel straight lines, all with arrows in one direction

(b) Concentric circles

(c) Parallel straight lines inside with closed return loops outside (like a bar magnet's whole field)

(d) Lines diverging from the axis at both ends

(a) Parallel straight lines with arrows in one direction <<

(b) Concentric circles

(c) Parallel straight lines inside with closed loops outside

(d) Lines diverging at both ends of the axis

Explanation:

Inside a current carrying solenoid the field is uniform: parallel straight lines in one direction (option a).

Option (c) shows the whole solenoid field including the return loops outside, not the pattern inside.

Q.15 [1 mark]

Identify the food chain in which the organisms of the second trophic level are missing:

(a) Grass, goat, lion

(b) Zooplankton, Phytoplankton, small fish, large fish

(c) Tiger, grass, snake, frog <<

(d) Grasshopper, grass, snake, frog, eagle

Explanation:

The 2nd trophic level is the herbivore (primary consumer) that eats the producer.

(a) Grass → goat → lion: goat is the herbivore — complete.

(b) Phytoplankton →

zooplankton →

small fish →

large fish: zooplankton is the herbivore — complete.

(c) Grass →

frog →

snake →

tiger: no herbivore eats the grass (the frog needs an insect such as a grasshopper) — 2nd trophic level missing.

(d) Grass → grasshopper → frog → snake → eagle: complete.

So the answer is (c).

Q.16 [1 mark]

In which of the following organisms, multiple fission is a means of asexual reproduction?

(a) Yeast

(b) Leishmania

(c) Paramoecium

(d) Plasmodium <<

Explanation:

Plasmodium (the malarial parasite) reproduces by multiple fission.

In this process, the parent cell divides into many daughter cells simultaneously.

Yeast reproduces by budding, Leishmania by binary fission, and Paramoecium by binary fission.

Q.17 [1 mark]

Assertion (A): Hydrogen gas is not evolved when zinc reacts with nitric acid.

Reason (R): Nitric acid oxidises the hydrogen gas produced to water and itself gets reduced.

Select the correct option:

(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:

It is true that hydrogen gas is not evolved when zinc (or most metals) reacts with nitric acid (HNO_3).

This is because HNO_3 is a strong oxidising agent that oxidises the H_2 produced to water, and itself gets reduced to nitrogen oxides (NO_2, NO, N_2O etc.).

Both A and R are true, and R correctly explains A.

Q.18 [1 mark]

Assertion (A): Accumulation of harmful chemicals is maximum in the organisms at the highest trophic level of a food chain.

Reason (R): Harmful chemicals are sprayed on the crops to protect them from diseases and pests.

Select the correct option:

(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 is true — this is called biological magnification, where the concentration of harmful non-biodegradable chemicals increases at each trophic level.

Reason is also true — pesticides are sprayed on crops.
However, R is not the correct explanation of A.
The correct explanation involves the concept of biomagnification, not just the spraying of chemicals.

Q.19 [1 mark]

Assertion (A): The rate of breathing in aquatic organisms is much faster than in terrestrial organisms.
Reason (R): The amount of oxygen dissolved in water is very high as compared to the amount of oxygen in air.
Select the correct option:

(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 is true — aquatic organisms do breathe faster because the amount of dissolved oxygen in water is much less than in air.
Reason is false — the amount of oxygen dissolved in water is actually LOW (not high) compared to oxygen in air.
Since A is true and R is false, option (c) is correct.

Q.20 [1 mark]

Assertion (A): The rainbow is a natural spectrum of sunlight in the sky.
Reason (R): Rainbow is formed in the sky when the sun is overhead and water droplets are also present in air.
Select the correct option:

(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 is true — the rainbow is indeed a natural spectrum of sunlight formed by dispersion.

Reason is false — a rainbow is NOT formed when the sun is overhead.

A rainbow is observed when the sun is behind the observer and rain is in front.

The sun should be low in the sky (not overhead) for a rainbow to be visible.

Section B

Very Short Answer Questions (2 marks each)

Q.21 [2 marks]

Name the type of chemical reaction in which calcium oxide reacts with water. Justify your answer by giving a balanced chemical equation for the chemical reaction.

Answer: This is a combination reaction (also exothermic). $CaO + H_2O \rightarrow Ca(OH)_2$. Calcium oxide (quicklime) combines with water to form calcium hydroxide (slaked lime). It is a combination reaction because two reactants combine to form a single product. The reaction is also exothermic as a large amount of heat is released.

Explanation:

$CaO + H_2O \rightarrow Ca(OH)_2$.

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

It is also exothermic.

Q.22 [2 marks]

State one role of each of the following in human digestive system:

(i) Hydrochloric acid

(ii) Villi

(iii) Anal Sphincter

(iv) Lipase

Answer: (i) Hydrochloric acid: It creates an acidic medium in the stomach, kills bacteria in food, and activates the enzyme pepsin.

(ii) Villi: They increase the surface area for absorption of digested food in the small intestine.

(iii) Anal Sphincter: It controls the release of faeces from the body (defecation).

(iv) Lipase: It breaks down (digests) fats/lipids into fatty acids and glycerol.

Explanation:

Each component plays a specific role in digestion: HCl for acidic medium and activating pepsin, villi for absorption, anal sphincter for controlling egestion, and lipase for fat digestion.

Q.23 [2 marks]

(A) How is the movement of leaves of a sensitive plant different from the downward movement of the roots?

Answer: Movement of leaves of a sensitive plant (Mimosa pudica) is a nastic movement — it is independent of the direction of stimulus and is caused by changes in water pressure (turgor) in the cells at the base of the leaves. It is a rapid, non-directional response.

The downward movement of roots is a tropic movement (positive geotropism/gravitropism) — it is in response to and in the direction of gravity. It is a slow, directional growth movement controlled by plant hormones (auxins).

Explanation:

Sensitive plant leaf movement is nastic (non-directional, caused by turgor changes, rapid).

Root downward movement is geotropism (directional, towards gravity, slow growth response mediated by auxins).

OR

Q.23 [2 marks]

(B) (OR for Q23) There is a hormone which regulates carbohydrate, protein and fat metabolism in our body. Name the hormone and the gland which secretes it. Why is it important for us to have iodised salt in our diet?

Answer: The hormone is Thyroxine (T_4) and it is secreted by the Thyroid gland. Thyroxine regulates the metabolism of carbohydrates, proteins and fats in the body. Iodised salt is important because iodine is essential for the synthesis of thyroxine. Deficiency of iodine in the diet can lead to a condition called goitre (swelling of the thyroid gland) as the gland enlarges to try to produce more thyroxine.

Explanation:

Thyroxine from the thyroid gland regulates metabolism.

Iodised salt provides iodine needed for thyroxine synthesis; deficiency causes goitre.

Q.24 [2 marks]

An object is placed at a distance of 10 cm from a convex mirror of focal length 15 cm. Find the position of the image formed by the mirror.

Answer: Given: u = -10 cm, f = +15 cm (convex mirror). Using mirror formula: 1/v + 1/u = 1/f. 1/v + 1/(-10) = 1/15. 1/v = 1/15 + 1/10 = (2+3)/30 = 5/30 = 1/6. Therefore v = +6 cm. The image is formed 6 cm behind the mirror. It is virtual, erect, and diminished.

Explanation:

Using mirror formula 1/v + 1/u = 1/f with u = -10 cm and f = +15 cm, we get v = +6 cm.

Image is virtual, erect and diminished, formed 6 cm behind the mirror.

Q.25 [2 marks]

(A) Show how you would connect three resistors each of resistance 6 Ω, so that the combination has a resistance of 9 Ω. Also justify your answer.

Answer: Connect two resistors in parallel and then connect this parallel

combination in series with the third resistor.

Two 6 Ω resistors in parallel: 1/Rp = 1/6 + 1/6 = 2/6 = 1/3, so Rp = 3 Ω.
Now connect this 3 Ω in series with the third 6 Ω resistor: R_total = 3 + 6 = 9 Ω.

Hence the combination has a total resistance of 9 Ω.

Explanation:
Two 6 Ω resistors in parallel give 3 Ω, connected in series with the third 6 Ω resistor gives 3 + 6 = 9 Ω.

OR

Q.25 [2 marks]

(B) (OR for Q25) In the given circuit calculate the power consumed in watts in the resistor of 2 Ω.
(Circuit: 1 Ω and 2 Ω resistors in series with a 6 V battery)

Answer: Total resistance R = 1 + 2 = 3 Ω.
Current I = V/R = 6/3 = 2 A.
Power in the 2 Ω resistor P = $I^2R = 2^2 \times 2 = 8$ W.

Explanation:
Series circuit: I = 6/(1+2) = 2 A through both resistors.
P = $I^2R = 4 \times 2 = 8$ W.

Q.26(a) [2 marks]

(i) Two magnetic field lines do not intersect each other. Why?
(ii) How is a uniform magnetic field in a given region represented? Draw a diagram in support of your answer.

Answer: (i) Two magnetic field lines never intersect because at the point of intersection, there would be two directions of the magnetic field, which is not possible. A compass needle placed at that point would point in two directions at once, which is impossible.

(ii) A uniform magnetic field is represented by parallel and equidistant straight lines. The lines are drawn as parallel straight arrows pointing in the same direction, with equal spacing between them.

Explanation:

Field lines don't intersect because it would imply two directions of magnetic field at one point.

Uniform field is shown by parallel equidistant straight lines.

Section C

Short Answer Questions (3 marks each)

Q.27 [3 marks]

Write one chemical equation each for the chemical reaction in which the following have taken place:

(i) Change in colour

(ii) Change in temperature

(iii) Formation of precipitate

Mention colour change/temperature change (rise/fall)/compound precipitated along with equation.

Answer: (i) Change in colour: $CuSO_4 + Fe \rightarrow FeSO_4 + Cu$. Blue colour of copper sulphate solution changes to green (ferrous sulphate) as iron displaces copper.

(ii) Change in temperature: $CaO + H_2O \rightarrow Ca(OH)_2$. Temperature rises (exothermic reaction) when quicklime reacts with water.

(iii) Formation of precipitate: $Na_2SO_4 + BaCl_2 \rightarrow BaSO_4\downarrow + 2NaCl$. White precipitate of barium sulphate ($BaSO_4$) is formed.

Explanation:

Three types of observable changes in chemical reactions demonstrated with balanced

equations and specific observations.

Q.28(a) [3 marks]

(i) The pH of a sample of tomato juice is 4.6. How is this juice likely to be in taste?

(ii) How do we differentiate between a strong acid and a weak base in terms of ion-formation in aqueous solutions?

(iii) The acid rain can make the survival of aquatic animals difficult. How?

Answer: (i) Since the pH of tomato juice is 4.6, which is less than 7, it is acidic. Therefore, it will taste sour.

(ii) A strong acid produces a large number of H^+ (hydrogen) ions in aqueous solution as it completely dissociates. A weak base produces fewer OH^- (hydroxide) ions in aqueous solution as it partially dissociates.

(iii) Acid rain lowers the pH of water bodies (rivers, lakes). When the pH of water goes below 5-6, it becomes too acidic for aquatic organisms to survive. The acidic water affects the metabolic processes of aquatic animals and can damage their gills and other organs.

Explanation:

pH 4.6 means sour taste (acidic).

Strong acids fully ionise producing more H+ ions; weak bases partially ionise.

Acid rain lowers water pH, making it difficult for aquatic life.

Q.29(a) [3 marks]

(i) Why is respiratory pigment needed in multicellular organisms with large body size?

(ii) Give reasons for the following:

(a) Rings of cartilage are present in the throat.

(b) Lungs always contain a residual volume of air.

(c) The diaphragm flattens and ribs are lifted up when we breathe in.

(d) Walls of alveoli contain an extensive network of blood vessels.

Answer: (i) In multicellular organisms with large body size, respiratory pigment (haemoglobin) is needed because simple diffusion of oxygen is not sufficient to supply oxygen to all cells. Haemoglobin binds with oxygen and transports it through the blood to all parts of the body.

(ii) (a) Rings of cartilage in the throat (trachea) ensure that the air passage does not collapse when there is no air in it.
(b) Lungs always contain a residual volume of air so that there is sufficient time for oxygen to be absorbed and CO_2 to be released. This ensures continuous gas exchange.
(c) When we breathe in, the diaphragm flattens and ribs are lifted up to increase the volume of the chest cavity, which decreases the air pressure inside, allowing air to rush into the lungs.
(d) Walls of alveoli have an extensive network of blood vessels (capillaries) to facilitate efficient exchange of gases (O_2 and CO_2) between the alveolar air and the blood.

Explanation:
Respiratory pigment transports O_2 in large organisms.
Cartilage rings keep trachea open.
Residual air ensures continuous gas exchange.
Diaphragm/ribs movement creates pressure difference.
Alveolar capillaries enable gas exchange.

Q.30 [3 marks]

Define reflex action. With the help of a flow chart show the path of a reflex action such as sneezing.

Answer: Reflex action is a sudden, involuntary and automatic response to a stimulus without the involvement of the brain. It is controlled by the spinal cord.

Flow chart for reflex action (sneezing):

Stimulus (irritant in nasal passage) → Receptor (sensory nerve endings in nose) → Sensory (afferent) nerve → Spinal cord (reflex centre) → Motor (efferent) nerve → Effector (muscles of diaphragm, chest, throat) → Response (sneezing)

The pathway is called reflex arc:

Receptor → Sensory neuron → Relay neuron (in spinal cord) → Motor neuron → Effector (muscle)

Explanation:

Reflex action is an involuntary, rapid response controlled by the spinal cord.

The reflex arc: Receptor → Sensory neuron → Spinal cord → Motor neuron → Effector.

Q.31 [3 marks]

Study the diagram given below and answer the questions that follow:

(The diagram shows an eye in which rays from an object at N' converge to a point behind the retina, with N marking the normal near point)

(i) Name the defect of vision represented in the diagram. Give reason for your answer.

(ii) List two causes of this defect.

(iii) With the help of a diagram show how this defect of vision is corrected.

Answer: (i) Hypermetropia (far-sightedness). In the diagram the rays converge behind the retina, so the image forms behind the retina; the near point is farther than the normal near point N.

(ii) Two causes of hypermetropia:

1. The focal length of the eye lens is too long (the eye lens is too thin / has low converging power).

2. The eyeball has become too small (short).

(iii) It is corrected by a convex (converging) lens of suitable power placed before

the eye. It adds converging power so the rays meet on the retina.

[Diagram: parallel/nearby-object rays pass through a convex lens, converge slightly, then the eye lens focuses them on the retina.]

Explanation:

Image behind the retina means hypermetropia.

Causes: long focal length of eye lens or short eyeball.

Corrected with a convex lens.

Q.32 [3 marks]

Name and state the rule to determine the direction of:

(i) magnetic field produced around a current carrying straight conductor.

(ii) force experienced by a current carrying straight conductor placed in a magnetic field which is perpendicular to it.

Answer: (i) Right-Hand Thumb Rule (Maxwell's Corkscrew Rule): If a current-carrying straight conductor is held in the right hand such that the thumb points in the direction of the current, then the curled fingers indicate the direction of the magnetic field lines around the conductor.

(ii) Fleming's Left-Hand Rule: Stretch the thumb, forefinger and middle finger of the left hand mutually perpendicular to each other. If the forefinger points in the direction of the magnetic field (B) and the middle finger points in the direction of the current (I), then the thumb gives the direction of the force (F) acting on the conductor.

Explanation:

Right-Hand Thumb Rule for magnetic field around a current-carrying conductor.

Fleming's Left-Hand Rule for force on a current-carrying conductor in a magnetic field.

Q.33 [3 marks]

(A) Plants → Deer → Lion

In the given food chain, what will be the impact of removing all the organisms of second trophic level on the first and third trophic level? Will the impact be the same for the organisms of the third trophic level in the above food chain if they were present in a food web? Justify.

Answer: If all deer (second trophic level/primary consumers) are removed:

Impact on first trophic level (Plants): The population of plants will increase enormously as there will be no herbivores to feed on them. This will lead to overcompetition among plants for resources.

Impact on third trophic level (Lions): Lions will have no food (deer) to eat, so they will starve and eventually die or migrate to other areas. Their population will decrease drastically.

In a food web: The impact on lions (third trophic level) would NOT be the same. In a food web, lions have multiple food sources (other herbivores like zebra, buffalo, etc.). So even if deer are removed, lions can feed on other organisms. Food webs provide alternative pathways for energy flow, making the ecosystem more stable.

Explanation:

Removing deer: plants overgrow, lions starve.

In a food web, the impact on lions would be less severe because they have alternative food sources.

OR

Q.33 [3 marks]

(B) (OR for Q33) A gas 'X' which is a deadly poison is found at the higher levels of atmosphere and performs an essential function.

Name the gas and write the function performed by this gas in the atmosphere. Which chemical is linked to the decrease in the level of this gas? What measures have been taken by an international organization to check the depletion of the layer containing this gas?

Answer: The gas 'X' is Ozone (O_3).

Function: The ozone layer in the upper atmosphere (stratosphere) absorbs harmful ultraviolet (UV) radiations from the Sun and protects living organisms on Earth from the damaging effects of UV rays (such as skin cancer, cataracts, damage to DNA).

Chemical linked to decrease: Chlorofluorocarbons (CFCs), which are used in refrigerators, air conditioners, and aerosol sprays, are linked to the depletion of the ozone layer.

Measures taken: The United Nations Environment Programme (UNEP) succeeded in forging an agreement (Montreal Protocol, 1987) to freeze and eventually phase out the production and use of CFCs and other ozone-depleting substances. Many countries have signed this agreement.

Explanation:

Ozone (O_3) protects from UV radiation.

CFCs cause its depletion.

UNEP's Montreal Protocol aims to phase out CFCs.

Section D

Long Answer Questions (5 marks each)

Q.34 [5 marks]

(A) (i) Define a homologous series of carbon compounds.

(ii) Why is the melting and boiling points of C_4H_8 higher than that of C_3H_6 or C_2H_4?

(iii) Why do we NOT see any gradation in chemical properties of a homologous series compounds?

(iv) Write the name and structures of (i) aldehyde and (ii) ketone with molecular formula C_3H_6O.

Answer: (i) A homologous series is a series of carbon compounds in which the same functional group substitutes for hydrogen on a carbon chain, and successive members differ by a $-CH_2-$ unit (or 14 u in molecular mass). Members have the same general formula and similar chemical properties.

(ii) C_4H_8 (butene) has a higher melting and boiling point than C_3H_6 (propene) or C_2H_4 (ethene) because as the molecular size (chain length/number of carbon atoms) increases, the van der Waals forces of attraction between molecules increase, requiring more energy to overcome them.

(iii) We do not see gradation in chemical properties because all members of a homologous series have the same functional group, and chemical properties are determined by the functional group. Since the functional group is the same, the chemical properties remain similar.

(iv) With molecular formula C_3H_6O:
- Aldehyde: Propanal (CH_3CH_2CHO)
- Ketone: Propanone/Acetone (CH_3COCH_3)

Explanation:
Homologous series: same functional group, successive members differ by CH_2.
Higher boiling point with more carbons due to stronger van der Waals forces.
Same functional group means similar chemical properties.
C_3H_6O: Propanal (aldehyde) and Propanone (ketone).

OR

Q.34 [5 marks]

(B) (OR for Q34) (i) Write the name and structure of an organic compound 'X' having two carbon atoms in its molecule and its name is suffixed with '-ol'. (ii) What happens when 'X' is heated with excess concentrated sulphuric acid at 443 K? Write the chemical equation for the reaction stating the conditions for the reaction. Also state the role played by concentrated

sulphuric acid in the reaction.

(iii) Name and draw the electron dot structure of hydrocarbon produced in the above reaction.

Answer: (i) The compound 'X' is Ethanol (C_2H_5OH or CH_3CH_2OH). Structure: H-C-C-O-H with H atoms bonded to each carbon.

(ii) When ethanol is heated with excess concentrated sulphuric acid at 443 K (170°C), dehydration occurs:

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

Ethanol → Ethene + Water

Concentrated sulphuric acid acts as a dehydrating agent (removes water from ethanol).

(iii) The hydrocarbon produced is Ethene ($CH_2=CH_2$). Electron dot structure shows each carbon sharing two pairs of electrons (double bond) with each other and two pairs with hydrogen atoms.

Explanation:

X is ethanol (CH_3CH_2OH).

Dehydration with conc.

H_2SO_4 at 443K gives ethene ($CH_2=CH_2$) + H_2O.

H_2SO_4 acts as dehydrating agent.

Q.35 [5 marks]

(A) (i) Name three techniques/devices used by human females to avoid pregnancy. Mention the side effects caused by each.

(ii) What will happen if in a human female (a) fertilisation takes place, (b) an egg is not fertilised?

Answer: (i) Three contraceptive techniques/devices:

1. Barrier method (e.g., Copper-T/IUD): It is placed in the uterus to prevent pregnancy. Side effects: may cause irritation, heavy bleeding, or infection.

2. Oral contraceptive pills: Hormonal pills that prevent ovulation. Side effects: nausea, weight gain, mood changes, hormonal imbalance.
3. Surgical method (Tubectomy): Fallopian tubes are cut and tied. Side effects: surgical complications, irreversible, infection risk.

(ii) (a) If fertilisation takes place: The fertilised egg (zygote) gets implanted in the uterus wall. The uterus lining thickens and is richly supplied with blood to nourish the growing embryo. Pregnancy begins.
(b) If the egg is not fertilised: The thick uterus lining breaks down and comes out through the vagina as blood and mucus. This is called menstruation, which occurs roughly every 28 days.

Explanation:
Contraceptive methods with side effects.
If fertilised: implantation and pregnancy.
If not fertilised: uterine lining sheds (menstruation).

OR

Q.35 [5 marks]

(B) (OR for Q35) (i) Draw a diagram showing spore formation in Rhizopus and label the (a) reproductive and (b) non-reproductive parts. Why does Rhizopus not multiply on a dry slice of bread?
(ii) Name and explain the process by which reproduction takes place in Hydra.

Answer: (i) Diagram of Rhizopus showing spore formation:
- Reproductive parts: Sporangium (spore-bearing structure at the top), Spores (inside the sporangium)
- Non-reproductive parts: Hyphae (thread-like filaments), Rhizoids (root-like structures)

Rhizopus does not multiply on a dry slice of bread because moisture is essential for the growth of Rhizopus. Spores need moisture to germinate and the fungus

requires a moist environment for its metabolic activities.

(ii) Hydra reproduces by Budding. In this process:
- A small outgrowth (bud) develops on the body of Hydra due to repeated cell division.
- The bud gradually grows and develops tentacles.
- When fully mature, the bud detaches from the parent body and becomes an independent organism.
- This is an asexual method of reproduction.

Explanation:
Rhizopus: sporangium and spores (reproductive), hyphae and rhizoids (non-reproductive).
Needs moisture.
Hydra reproduces by budding.

Q.36 [5 marks]

(A) (i) Define electric power. Express it in terms of potential difference (V) and resistance (R).
(ii) An electric oven is designed to work on the mains voltage of 220 V. This oven consumes 11 units of electrical energy in 5 hours. Calculate:
(a) power rating of the oven
(b) current drawn by the oven
(c) resistance of the oven when it is red hot

Answer: (i) Electric power is the rate at which electrical energy is consumed or dissipated in a circuit. $P = VI = V^2/R = I^2R$. In terms of V and R: $P = V^2/R$.

(ii) Given: V = 220 V, Energy = 11 units (kWh) = 11 kWh, Time = 5 hours.

(a) Power = Energy/Time = 11 kWh / 5 h = 2.2 kW = 2200 W.

(b) $P = VI$, so $I = P/V = 2200/220 = 10$ A.

(c) $P = V^2/R$, so $R = V^2/P = (220)^2/2200 = 48400/2200 = 22\ \Omega$.

Explanation:
$P = V^2/R$.
Power = 11/5 = 2.2 kW = 2200 W.
Current = 2200/220 = 10 A.
Resistance = $220^2/2200 = 22\ \Omega$.

OR

Q.36 [5 marks]

(B) (OR for Q36) (i) Write the relation between resistance R and electrical resistivity ρ of the material of a conductor in the shape of cylinder of length l and area of cross-section A. Hence derive the SI unit of electrical resistivity.
(ii) The resistance of a metal wire of length 3 m is 60 Ω. If the area of cross-section of the wire is 4×10^{-7} m², calculate the electrical resistivity of the wire.
(iii) State how would electrical resistivity be affected if the wire (of part ii) is stretched so that its length is doubled. Justify your answer.

Answer: (i) $R = \rho l/A$, where R = resistance, ρ = resistivity, l = length, A = area of cross-section.
SI unit of resistivity: $\rho = RA/l$. Unit = $(\Omega)(m^2)/(m) = \Omega\cdot m$ (ohm-metre).

(ii) Given: l = 3 m, R = 60 Ω, $A = 4\times10^{-7}$ m².
$\rho = RA/l = (60 \times 4\times10^{-7})/3 = 240\times10^{-7}/3 = 80\times10^{-7} = 8\times10^{-6}\ \Omega\cdot m$.

(iii) Electrical resistivity would NOT be affected if the wire is stretched. Resistivity is a property of the material and does not depend on the dimensions (length, area) of the conductor. It remains the same ($8\times10^{-6}\ \Omega\cdot m$) regardless of the shape or size of the wire.

Explanation:

R = ρl/A, unit of ρ is Ω·m.

Resistivity = $(60\times4\times10^{-7})/3 = 8\times10^{-6}$ Ω·m.

Resistivity is a material property, unaffected by stretching.

Section E

Case Study Based Questions (4 marks each)

Q.38 [4 marks]

Case Study Q38: Mendel worked out the rules of heredity by working on garden pea using a number of visible contrasting characters. He conducted several experiments by making a cross with one or two pairs of contrasting characters of pea plant. On the basis of his observations he gave some interpretations which helped to study the mechanism of inheritance.

(i) When Mendel crossed pea plants with pure tall and pure short characteristics to produce F_1 progeny, which two observations were made by him in F_1 plants?

(ii) Write one difference between dominant and recessive trait.

(iii) (A) In a cross with two pairs of contrasting characters:

RRYY × rryy (Round Yellow × Wrinkled Green)

Mendel observed 4 types of combinations in F_2 generation. By which method did he obtain F_2 generation? Write the ratio of the parental combinations obtained and what conclusions were drawn from this experiment.

Answer: (i) Two observations in F_1:

1. All F_1 plants were tall — no short plants appeared.

2. Only one of the parental traits (tallness) was expressed in F_1, showing that tall is dominant over short (dwarf).

(ii) Dominant trait: The trait that is expressed in the F_1 generation (heterozygous condition). Example: Tallness (T).

Recessive trait: The trait that is suppressed/hidden in the F_1 generation and appears only in the homozygous condition. Example: Dwarfness (t).

(iii) (A) Mendel obtained F_2 by self-pollination of F_1 plants (RrYy × RrYy).
F_2 ratio: 9 Round Yellow : 3 Round Green : 3 Wrinkled Yellow : 1 Wrinkled Green (9:3:3:1).
Parental combinations ratio: Round Yellow and Wrinkled Green = 9:1.
Conclusions:
1. Genes for different characters are inherited independently (Law of Independent Assortment).
2. New combinations of traits appear in F_2 (Round Green, Wrinkled Yellow) that were not present in either parent.

Explanation:
F_1: all tall (dominant).
Dominant is expressed in heterozygous condition.
F_2 from self-pollination gives 9:3:3:1 ratio, proving independent assortment.

OR

Q.38 [4 marks]

Case Study Q38 (iii) (B) (OR): Justify the statement: 'It is possible that a trait is inherited but may not be expressed.'

Answer: This statement is justified because recessive traits can be inherited but not expressed when a dominant allele is present. For example, in Mendel's experiment:
- When TT (tall) × tt (short) cross is made, F_1 generation is all Tt (tall).
- The trait for shortness (t) has been inherited by F_1 plants, but it is not expressed because the dominant allele (T) masks it.
- However, when F_1 (Tt) plants are self-crossed: Tt × Tt → TT : Tt : tt = 1:2:1.
- The short trait reappears in F_2 in the tt (homozygous recessive) offspring.

Thus, the recessive trait was inherited in F_1 but was not expressed. It was only

expressed in F_2 when both recessive alleles came together.

Explanation:

Recessive traits are inherited but not expressed in heterozygous condition.

They appear when homozygous recessive condition occurs (e.g., tt in F_2).

Q.39(a) [4 marks]

Case Study Q39: Study the data given below showing the focal length of three concave mirrors A, B and C and the respective distances of objects placed in front of the mirrors:

Mirror A: Focal length = 20 cm, Object distance = 45 cm
Mirror B: Focal length = 15 cm, Object distance = 30 cm
Mirror C: Focal length = 30 cm, Object distance = 20 cm

(i) In which one of the above cases the mirror will form a diminished image of the object? Justify your answer.

Answer: Mirror A will form a diminished image.

For Mirror A: f = 20 cm, so 2f = 40 cm. Object distance u = 45 cm, which is beyond 2f (45 > 40). When an object is placed beyond 2f (centre of curvature) of a concave mirror, the image formed is real, inverted and diminished (smaller than the object).

For Mirror B: f = 15 cm, 2f = 30 cm. Object at u = 30 cm is at 2f, so image is same size.

For Mirror C: f = 30 cm, 2f = 60 cm. Object at u = 20 cm is between the pole and F (20 < 30), so the image is virtual, erect and enlarged.

Explanation:

Mirror A: object at 45 cm is beyond 2f (40 cm), so image is diminished.

Mirror B: object at 2f gives same size.

Mirror C: object (20 cm) is inside f (30 cm), giving an enlarged virtual image.

Q.39(b) [4 marks]

Case Study Q39 continued:

(ii) List two properties of the image formed in case 2 (Mirror B: f = 15 cm, object at 30 cm).

Answer: For Mirror B (object at 2f = 30 cm):

1. The image is real (formed on the same side as the object).
2. The image is inverted (upside down).

Additional properties: The image is of the same size as the object and is formed at a distance of 2f (30 cm) from the mirror.

Explanation:

At 2f of a concave mirror: image is real, inverted, same size as object, formed at 2f on same side.

Q.39(c) [4 marks]

Case Study Q39 continued:

(iii) (A) What is the nature and size of the image formed by mirror C? Draw ray diagram to justify your answer.

Answer: For Mirror C: f = 30 cm, object distance = 20 cm (object lies between the pole and the focus since 20 < 30).

The image formed is:

- Virtual (cannot be obtained on a screen)
- Erect
- Magnified (larger than the object)
- Formed behind the mirror

Ray diagram: Draw a concave mirror with F at 30 cm and the object at 20 cm. Draw two rays:

1. A ray parallel to the principal axis, which after reflection passes through F.

2. A ray directed towards the centre of curvature C, which reflects back along the same path.

The reflected rays diverge; when extended behind the mirror they meet to form a virtual, erect, enlarged image.

Explanation:

Mirror C has f = 30 cm and u = 20 cm, so the object is between pole and focus: image is virtual, erect and enlarged.

OR

Q.39(c) [4 marks]

Case Study Q39 (iii) (B) (OR): An object is placed at a distance of 18 cm from the pole of a concave mirror of focal length 12 cm. Find the position of the image formed in this case.

Answer: Given: u = -18 cm, f = -12 cm (concave mirror, both negative by sign convention).

Using mirror formula: 1/v + 1/u = 1/f

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

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

1/v = (-3 + 2)/36

1/v = -1/36

v = -36 cm

The image is formed at a distance of 36 cm in front of the mirror (on the same side as the object). The negative sign indicates the image is real.

The image is real, inverted and magnified (since |v| > |u|).

Explanation:

Using 1/v + 1/u = 1/f: 1/v = -1/12 + 1/18 = -1/36, so v = -36 cm.

Image is real, inverted, magnified, formed 36 cm in front of the mirror.

Q.0

Case Study Q37 (Section E - Electrolytic Refining): The metals produced by various reduction processes are not very pure. They contain impurities, which must be removed to obtain pure metals. The most widely used method for refining impure metals is electrolytic refining.

(i) What is the cathode and anode made of in the refining of copper by this process?

(ii) Name the solution used in the above process and write its formula.

(iii) (A) How copper gets refined when electric current is passed in the electrolytic cell?

Answer: (i) In electrolytic refining of copper:

- Cathode: A thin strip of pure copper
- Anode: A thick block of impure copper

(ii) The solution (electrolyte) used is acidified copper sulphate solution ($CuSO_4$).

(iii) (A) When electric current is passed:

- The impure copper at the anode dissolves into the electrolyte as Cu^{2+} ions: $Cu \rightarrow Cu^{2+} + 2e^-$
- These Cu^{2+} ions from the solution are deposited on the cathode as pure copper: $Cu^{2+} + 2e^- \rightarrow Cu$
- The impurities from the anode settle at the bottom as anode mud.
- Thus, pure copper is deposited on the cathode while the impure anode gradually dissolves.

Explanation:

Cathode: pure copper strip.

Anode: impure copper block.

Electrolyte: acidified $CuSO_4$ solution.

Impure Cu dissolves from anode, pure Cu deposits on cathode.

Q.0

Case Study Q37 (iii) (B) (OR): You have two beakers 'A' and 'B' containing copper sulphate solution. What would you observe after about 2 hours if you dip a strip of zinc in beaker 'A' and a strip of silver in beaker 'B'? Give reason for your observations in each case.

Answer: Beaker A (Zinc in $CuSO_4$ solution):

- The blue colour of copper sulphate solution will fade/become colourless (turns to zinc sulphate).
- A reddish-brown deposit of copper will appear on the zinc strip.
- Reason: Zinc is more reactive than copper, so it displaces copper from $CuSO_4$ solution.
- Reaction: $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

Beaker B (Silver in $CuSO_4$ solution):

- No change will be observed. The blue colour remains the same and no deposit appears on the silver strip.
- Reason: Silver is less reactive than copper, so it cannot displace copper from $CuSO_4$ solution. (Silver is below copper in the reactivity series.)

Explanation:

Zinc displaces copper (more reactive): solution decolourises, Cu deposits on Zn.

Silver cannot displace copper (less reactive): no change.