CBSE EXAMINATION PAPER-2023

SCIENCE

(Solved)

Time allowed : 3 hours | Maximum Marks : 75

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **34 questions.** All questions are **compulsory.**

ii. This question paper is divided into **5 sections.**

iii. **Section A** – questions number **1 to 12** are multiple choice questions Each question carries **1 marks.**

iv. **Section B** – questions number **13 to 19** are very short answer Each question carries **2 marks.**

v. **Section C** – questions number **20 to 27** are short answer Each question carries **3 marks.**

vi. **Section D** – questions number **28 to 29** are case based questions

vii. **Section E** – questions number **30 to 34** are long answer Each question carries **5 marks.**

viii. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.

ix. Use of calculator is NOT allowed.

Section A

Question 1. Select a pair of olfactory indicators from the following:

[1 Marks]

(A) Clove oil and litmus solution

(B) Onion and turmeric

(C) Clove oil and vanilla essence

(D) Vanilla and methyl orange

Explanation: Olfactory indicators are substances whose odour changes in the presence of acids or bases. According to the given context, both vanilla essence and clove oil are mentioned as olfactory indicators because their smell changes when exposed to dilute acid (HCl) or base (NaOH) solutions. Therefore, the correct pair of olfactory indicators is 'Clove oil and vanilla essence'. Options like litmus solution, turmeric, onion, and methyl orange are not olfactory indicators as their odour does not change with acids or bases.

Question 2. Fresh milk has a pH of 6. To delay its curdling, a chemical substance is added to it, which is:

[1 Marks]

(A) Sodium carbonate

(B) Baking powder

(C) Sodium hydroxide (Caustic soda)

(D) Baking soda (Sodium hydrogen carbonate)

Explanation: Fresh milk has a slightly acidic pH of about 6. Curdling happens due to formation of lactic acid which lowers the pH further and causes milk proteins to coagulate. To delay curdling, a mild base is added to neutralize the acid and raise the pH towards neutral. Baking soda (sodium hydrogen carbonate) is a mild base commonly used to delay curdling by neutralizing acids without being too strong. Sodium hydroxide and sodium carbonate are much stronger bases and may cause unwanted reactions or be unsafe. Baking powder contains baking soda along with mild edible acids and may not effectively delay curdling alone. Hence, baking soda is the correct chemical substance added to milk to delay curdling.

Question 3. Which of the following statements is true for an amphoteric oxide?

[1 Marks]

(A) It reacts only with acid and does not form water.

(B) It reacts with acid as well as base to form salt and hydrogen gas.

(C) It reacts only with base and does not form water.

(D) It reacts with both acid as well as base to form salt and water.

Explanation: The correct statement is: 'It reacts with both acid as well as base to form salt and water.' Amphoteric oxides, like aluminium oxide, react with acids to form salts and water, and also react with bases to form salt and water, showing both acidic and basic behavior.

Question 4. Hydronium ions are formed by the reaction between:

[1 Marks]

(A) Sodium hydroxide and water

(B) Calcium chloride and water

(C) Hydrogen chloride gas and water

(D) Ethanol and water

Explanation: The correct option is 'Hydrogen chloride gas and water'. According to the context, when hydrogen chloride (HCl) gas reacts with water, hydrogen ions (H^+) from HCl combine with water molecules (H_2O) to form hydronium ions (H_3O^+). This is shown by the reaction: $HCl + H_2O \rightarrow H_3O^+ + Cl^-$. Hydronium ions cannot be formed by the other options listed.

Question 5. The process in which loss of water in the form of vapours from the aerial parts of plants takes place is X, which helps in Y. Here X and Y respectively are:

[1 Marks]

(A) transpiration and photosynthesis

(B) transpiration and temperature regulation

(C) translocation and movement of soluble products of photosynthesis in phloem

(D) translocation and absorption of water and minerals from soil by roots

Explanation: The correct answer is "transpiration and temperature regulation." Transpiration is the process of water loss in the form of vapor from the aerial parts of plants, mainly through stomata. This process creates a suction that pulls water and minerals from the roots to the leaves. Besides aiding nutrient absorption, transpiration also helps regulate the temperature of the plant by cooling it through evaporation.

Question 6. As compared to terrestrial organisms, the rate of breathing in aquatic organisms is:

[1 Marks]

(A) faster because they need more oxygen for their survival

(B) faster because the amount of dissolved oxygen in water is fairly low

(C) slower because the amount of dissolved oxygen in water is fairly low

(D) slower because the capacity of water of dissolving atmospheric air is limited

Explanation: The correct option is 'faster because the amount of dissolved oxygen in water is fairly low'. Aquatic organisms like fishes breathe faster than terrestrial organisms because the amount of oxygen dissolved in water is much less compared to the oxygen available in the air. Therefore, to meet their oxygen needs, aquatic animals have a faster breathing rate, taking water in through their mouths and passing it over their gills to extract oxygen.

Question 7. The part in which gustatory receptors are present in our body is:

[1 Marks]

(A) inner lining of nose

(B) skin

(C) inner ear

(D) tongue

Explanation: The correct option is 'tongue' because gustatory receptors are responsible for detecting taste and are located in the tongue. The tongue contains taste buds, which have sensory cells that detect specific molecules from food and send signals to the brain to interpret taste. Other options like the inner lining of the nose contain olfactory receptors for smell, the skin has receptors for touch and temperature, and the inner ear is related to balance and hearing, not taste.

Question 8. An electric kettle consumes 1 kW of electric power when operated at 220 V. The minimum rating of the fuse wire to be used for it is:

[1 Marks]

(A) 1 A

(B) 2 A

(C) 4 A

(D) 5 A

Explanation: The current drawn by the kettle is calculated by dividing power by voltage, i.e., 1000 W ÷ 220 V = 4.54 A approximately. Since the fuse wire should have a rating slightly above the current to avoid blowing unnecessarily, a 5 A fuse should be used. This ensures safety and proper functioning without frequent fuse blows.

Question 9. For a current in a long straight solenoid, N and S poles are created at the two ends. Among the following statements, the incorrect statement is:

[1 Marks]

(A) The magnetic field lines inside the solenoid are in the form of straight lines, which indicates that the magnetic field is uniform at all points inside the solenoid.

(B) The N and S poles exchange positions when the direction of current through the solenoid is reversed.

(C) The strong magnetic field produced inside the solenoid can magnetize the soft iron placed inside it.

(D) The pattern of the magnetic field associated with a current carrying solenoid is different from the pattern of the magnetic field around a bar magnet.

Explanation: The incorrect statement is: 'The pattern of the magnetic field associated with a current carrying solenoid is different from the pattern of the magnetic field around a bar magnet.' According to the provided context, the magnetic field pattern of a current-carrying solenoid is actually similar to that of a bar magnet, with one end behaving like a north pole and the other like a south pole. The other statements are correct because the field lines inside a solenoid are straight and parallel indicating a uniform magnetic field, the poles do switch positions if the current direction is reversed, and a strong magnetic field is produced inside the solenoid which can magnetize soft iron placed inside it.

Question 10.

Assertion (A): Human populations show a great deal of variations in traits.

Reason (R): All variations in a species have equal chances of surviving in the environment in which they live.

[1 Marks]

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

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

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

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

Explanation: Assertion (A) is true because human populations show a great deal of variation as indicated by the differences in traits among individuals. Reason (R) is false because not all variations have equal chances of survival; some variations may increase

an individual's chances of survival in a given environment, while others may not be beneficial. Therefore, the correct option is 'Assertion (A) is true, but Reason (R) is false.'

Question 11.

Assertion (A): The walls of atria are thicker than those of the ventricles.

Reason (R): Ventricles have to pump blood into various organs at high pressure.

[1 Marks]

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

(B) Both Assertion (A) and Reason (R) are true and Reason (R) is 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: The assertion is false because the walls of the atria are thinner than those of the ventricles. This is because the ventricles pump blood to various organs and therefore require thicker, more muscular walls to generate high pressure. Hence, the reason is true, but the assertion is false.

Question 12.

Assertion (A): Two magnetic field lines around a current carrying straight wire do not intersect each other.

Reason (R): The magnitude of the magnetic field produced at a given point increases as the current through the wire increases.

[1 Marks]

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

(B) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

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

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

Explanation: Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). Two magnetic field lines around a current carrying

straight wire do not intersect because if they did, it would mean two different directions of magnetic field at the same point, which is impossible. The reason given, that the magnetic field magnitude increases with current, is true but does not explain why the lines do not intersect.

Section B

Question 13.

On heating 'X' at 373 K, it loses water molecules and becomes 'Y'. 'Y' is a substance which doctors use for supporting fractured bones in the right position.

(i) Identify 'X' and 'Y'.

(ii) How can 'X' be reobtained from 'Y'?

[2 Marks]

Answer: (i) 'X' is gypsum, which is calcium sulphate dihydrate $CaSO_4 . 2H_2O$.
'Y' is Plaster of Paris, which is calcium sulphate hemihydrate $CaSO_4 . 1/2H_2O$.
(ii) 'X' (gypsum) can be reobtained from 'Y' (Plaster of Paris) by adding water to Plaster of Paris. It reacts with water and forms gypsum again which sets into a hard solid mass. This process is called hydration.

Question 14.

Two solutions M and N give Red and Blue colour respectively with a universal indicator.

(i) In which solution will the hydrogen ion concentration be more? Justify your answer.

(ii) If both M and N solutions are mixed and the resultant mixture is tested with a universal indicator, it turns green. What is the nature of the salt formed? Justify your answer.

[2 Marks]

Answer:

(i) Solution M gives a red colour with a universal indicator, which means it is acidic. Acidic solutions have more hydrogen ions (H+). Hence, hydrogen ion concentration is more in solution M.

(ii) When solutions M and N are mixed, the universal indicator turns green, indicating the solution is neutral. This means the hydrogen ions from the acidic solution M have been neutralised by the hydroxide ions from the basic solution N, resulting in the formation of a neutral salt.

Question 15.

Write the name and function of parts (i) and (ii) in the diagram of a neuron given below.

[2 Marks]

Answer: (i) **Dendrite**: Its function is to receive electrical signals or information from other neurons.
(ii) **Axon**: Its function is to carry electrical impulses away from the cell body towards other neurons, muscles, or glands.

Question 16.

List the events in proper sequence that take place during the process of photosynthesis.

[2 Marks]

Answer: Photosynthesis is the process by which plants make their food using sunlight. The first event is the absorption of light energy by chlorophyll in the leaves. Next, the light energy is converted into chemical energy. Water molecules are then split into hydrogen and oxygen using this energy. The plant takes carbon dioxide from the air. Finally, using hydrogen and carbon dioxide, the plant produces glucose (a sugar) and releases oxygen into the air.

Question 17.

Explain in brief two ways by which leaves of a plant help in excretion.

[2 Marks]

Answer: Leaves of a plant help in excretion mainly through transpiration and guttation. Transpiration is the process where water absorbed by roots moves up and evaporates as water vapor through small pores called stomata on the leaves, removing excess water. Guttation occurs when excess water, along with dissolved waste products, is released as droplets from specialized structures on leaf edges. Thus, leaves remove waste products and excess water from plants.

Question 18.

In the process of digestion of food in human beings, two protein-digesting enzymes are secreted. Name the enzymes along with the glands that secrete them.

[2 Marks]

Answer: In human digestion, two important enzymes that digest proteins are Pepsin and Protease. Pepsin is secreted by the gastric glands in the stomach, where it breaks down proteins into smaller peptides. Protease, on the other hand, is secreted by the pancreas

and released into the small intestine to further digest proteins into amino acids. These enzymes play vital roles in protein digestion during the digestive process.

Question 19.

In the given food chain, if 50 J of energy is available to the hawk, how much energy is present at the first and third trophic levels? Justify your answer.

Grass → Grasshopper → Frog → Snake → Hawk

[2 Marks]

Answer: In a food chain, energy decreases at each trophic level because energy is lost as heat and used for metabolic activities. The given food chain has five trophic levels: grass (producer), grasshopper (primary consumer), frog (secondary consumer), snake (tertiary consumer), and hawk (quaternary consumer). If 50 J of energy is available to the hawk (fifth level), we can calculate the energy at the first and third levels by considering that only about 10% of energy is transferred from one level to the next. Therefore, the energy at the snake (fourth level) is 500 J, at the frog (third level) is 5000 J, and at the grass (first level) is 50000 J. Hence, the first trophic level (grass) has 50000 J and the third trophic level (frog) has 5000 J of energy. This shows that energy decreases considerably along the food chain, leading to less energy available at higher levels.

Section C

Question 20.

(a) Define a double displacement reaction.

(b) Write the chemical equation of a double displacement reaction which is also a

(i) Neutralization reaction and

(ii) Precipitation reaction. Give justification for your answer.

[3 Marks]

Answer: (a) A double displacement reaction is a type of chemical reaction where two compounds exchange their ions to form two new compounds. This usually takes place in aqueous solutions, and the positive ions (cations) and negative ions (anions) swap partners.

(b)(i) Example of a double displacement reaction that is also a neutralization reaction:
$HCl\ (aq) + NaOH\ (aq) \rightarrow NaCl\ (aq) + H_2O\ (l)$
This is a neutralization reaction because an acid (HCl) reacts with a base (NaOH) to produce a salt (NaCl) and water.

(b)(ii) Example of a double displacement reaction that is also a precipitation reaction:
$BaCl_2$ (aq) + Na_2SO_4 (aq) -> $BaSO_4$ (s) + 2NaCl (aq)
This is a precipitation reaction because $BaSO_4$ forms as a white solid (precipitate) which is insoluble in water. It is also a double displacement reaction as Ba^{2+} and Na^{+} ions exchange their anions SO_4^{2-} and Cl^{-}.

Question 21.

(a) Sometimes the pH of our mouth gets lower than 5.5. Why?

(b) A basic salt X' is obtained by heating baking soda followed by crystallisation. Identify 'X' and state its two industrial uses.

(c) Why do copper sulphate crystals turn white on heating?

[3 Marks]

Answer: (a) The pH of our mouth becomes lower than 5.5 because bacteria present in the mouth break down the food particles, especially sugars, producing acids. These acids lower the pH, making the mouth acidic. (b) When baking soda (sodium hydrogen carbonate) is heated, it decomposes to form sodium carbonate (Na_2CO_3), which is the basic salt 'X'. Industrial uses of sodium carbonate include manufacturing glass and paper, and in soap and detergent production. (c) Copper sulphate crystals are blue due to water of crystallisation present in them. On heating, this water is removed as steam, and the crystals lose their blue colour, turning white because anhydrous copper sulphate is white in color.

Question 22.

(i) An object of 5 cm height is placed at a distance of 20 cm from the optical centre of a concave lens of focal length 18 cm. Calculate

(1) image distance and

(2) the magnification in this case.

(ii) Compare the values of magnification obtained by a concave lens and a convex lens when both the lenses form virtual images.

[3 Marks]

Answer:

(i) Calculation of image distance (v):
Given: Object height h = 5 cm, Object distance u = -20 cm (since object distance is always negative for lenses), Focal length f = -18 cm (concave lens focal length is negative).

Using lens formula, 1/f = 1/v - 1/u
=> 1/v = 1/f + 1/u = 1/(-18) + 1/(-20) = -1/18 - 1/20 = - (10/180 + 9/180) = -19/180
So, v = -180/19 ≈ -9.47 cm.

(ii) Calculation of magnification (m):
Magnification m = v / u = (-9.47) / (-20) = 0.47.
Magnification is positive and less than 1, indicating the image is virtual, erect, and diminished.

(iii) Comparison of magnification for concave and convex lenses when both form virtual images:
A concave lens always forms virtual, erect, and smaller images, so magnification is positive but less than 1.
A convex lens forms virtual images only when the object is placed between the lens and its focal point; in this case, the magnification is positive and greater than 1 indicating virtual, erect, and magnified images.
Therefore, the magnification of a convex lens is greater than 1 for virtual images, whereas for a concave lens it is less than 1.

Question 23.

A convex lens can form a

(i) real, inverted and magnified image as well as

(ii) virtual, erect and magnified image of an object. If the focal length of the lens is 10 cm, what should be the range of the object distance in both cases ? Draw ray diagrams to justify your answer.

[3 Marks]

Answer:

A convex lens can form two types of magnified images depending on the position of the object relative to the focal length (10 cm) of the lens.

Case (i): Real, inverted and magnified image
For this type of image, the object should be placed between the focal length (10 cm) and twice the focal length (20 cm) from the lens. When the object distance is between 10 cm and 20 cm, the lens forms a real, inverted, and magnified image on the other side of the lens beyond 20 cm.

Case (ii): Virtual, erect and magnified image
For this case, the object must be placed closer to the lens than the focal length, that is within 10 cm of the lens. When the object is inside the focal length, the lens produces a virtual, erect, and magnified image on the same side as the object.

Ray Diagrams:

In the first case, rays converge on the opposite side forming a real image while in the second, rays appear to diverge from a point on the same side, creating a virtual image. The image formed in the first case can be obtained on a screen, but the virtual image in the second case cannot be projected on a screen.

Question 24.

(a) State one important function of the following parts of the human eye :

(i) Retina

(ii) Pupil

(b) State the role of ciliary muscles in focussing objects at varying distances from the eye.

[3 Marks]

Answer:

(a)

(i) The retina is the light-sensitive layer at the back of the eye that captures the light rays focused by the lens and converts them into electrical signals. These signals are then sent to the brain through the optic nerve, allowing us to see images.

(ii) The pupil is the opening in the center of the iris that controls the amount of light entering the eye. It adjusts in size — becoming small in bright light and large in dim light — to protect the eye and improve vision.

(b)

The ciliary muscles play a crucial role in focusing objects at different distances, a process called accommodation. When we look at nearby objects, the ciliary muscles contract, causing the crystalline lens to become thicker and more curved. This increases the lens's focusing power, allowing the eye to clearly see close objects. Conversely, when looking at distant objects, the ciliary muscles relax, making the lens thinner and less curved, which helps focus light from far objects onto the retina correctly. Thus, the ciliary muscles adjust the lens shape to ensure sharp vision at varying distances.

Question 25.

(i) A straight cylindrical conductor is suspended with its axis perpendicular to the magnetic field of a horse-shoe magnet. The conductor gets displaced towards left when a current is passed through it. What will happen to the displacement of the conductor if the

(1) current through it is increased ?

(2) horse-shoe magnet is replaced by another stronger horse-shoe magnet ?

(3) direction of current through it is reversed?

(ii) Name and state the rule for determining the direction of force on a current carrying conductor in a magnetic field.

[3 Marks]

Answer:

(i) Effects on the displacement of the conductor:

1. If the current through the conductor is increased, the force acting on the conductor increases. Hence, the displacement of the conductor towards left will increase because the force on the conductor in a magnetic field is directly proportional to the current.

2. If the horse-shoe magnet is replaced by a stronger magnet, the magnetic field strength increases. Since the force on the conductor is also proportional to the magnetic field strength, the conductor will experience a greater force and thus its displacement towards left will increase.

3. If the direction of the current through the conductor is reversed, the direction of the force experienced by the conductor will also reverse. Therefore, the conductor will be displaced towards the right side instead of left.

(ii) Name and state the rule:

The rule is Fleming's Left-Hand Rule. It states that if you align your left hand such that the first finger points in the direction of the magnetic field (from North to South), the second finger points in the direction of the current (from positive to negative), then the thumb will point in the direction of the force or motion experienced by the conductor in the magnetic field.

Question 26.

Draw the pattern of the magnetic field produced around a vertical current carrying straight conductor passing through a horizontal cardboard. Mark the direction of current and the magnetic field lines. Name and state the rule which is used to determine the direction of magnetic field associated with a current carrying conductor.

[3 Marks]

Answer:

The magnetic field produced around a vertical current-carrying straight conductor passing through a horizontal cardboard consists of concentric circles around the conductor. The conductor is represented as a dot (if the current is coming out of the cardboard) or a cross (if the current is going into the cardboard). The direction of the

magnetic field lines can be determined using the **Right-Hand Thumb Rule**. According to this rule, if you point the thumb of your right hand in the direction of the current, then the curl of your fingers around the conductor shows the direction of the magnetic field lines. For example, if the current flows upward (out of the cardboard), the magnetic field lines will be in the anticlockwise direction around the conductor. The key here is that magnetic field lines form closed loops around the current-carrying conductor.

Question 27.

How is ozone formed in the higher levels of the atmosphere? "Damage to the ozone layer is a cause of concern." Justify this statement.

[3 Marks]

Answer: Ozone in the higher levels of the atmosphere, also called the ozone layer, is formed when ultraviolet (UV) light from the Sun breaks oxygen molecules (O_2) into single oxygen atoms. These single oxygen atoms then combine with oxygen molecules to form ozone (O_3). Although ozone is poisonous at ground level, in the ozone layer it plays a crucial role by absorbing harmful UV radiation from the Sun. Damage to this ozone layer is a cause of concern because it reduces the protection against UV rays. Increased UV radiation reaching Earth's surface can cause serious health issues, such as skin cancer and cataracts in humans, and harm animals and plants. Therefore, preserving the ozone layer is essential to protect life on Earth.

Section D

Question 28. In some families, either rural or urban, females are tortured for giving birth to a female child. They do not understand the scientific reason behind the birth of a boy or a girl. In fact, the mother is not responsible for the sex of the child and it has been genetically proved that the sex of a newborn is determined by what the child inherits from the father.

(1) State the basis on which the sex of a newborn baby is determined in humans.

[1 Marks]

Answer: The sex of a newborn baby in humans is determined by the chromosomes inherited from the parents, specifically from the father. Humans have sex chromosomes called X and Y. The mother always contributes an X chromosome, but the father can contribute either an X or a Y chromosome. If the baby inherits an X chromosome from the father, the baby will be a girl (XX). If the baby inherits a Y chromosome from the father, the baby will be a boy (XY). Therefore, the sex of the baby depends on whether the father passes an X or Y chromosome to the child.

Key Points: Sex determination is based on chromosomes-Sex chromosomes are X and Y-Mother always gives X chromosome-Father gives X or Y chromosome-If father gives X, baby is girl (XX)-If father gives Y, baby is boy (XY)-Sex is determined by father's chromosome inheritance

(2) Why is the pair of sex chromosomes called a mismatched pair in males?

[1 Marks]

Answer: The pair of sex chromosomes is called a mismatched pair in males because the two chromosomes are different in size and shape. Males have one X chromosome, which is normal-sized, and one Y chromosome, which is shorter. This difference makes the pair 'mismatched'. In contrast, females have two X chromosomes of the same size and shape, making their pair 'matched'.

Key Points: Males have XY sex chromosomes-Male sex chromosomes differ in size and shape-X chromosome is large and Y chromosome is short-Called mismatched due to difference-Females have XX chromosomes which are matched

(3) How is the original number of chromosomes present in the parents restored in the progeny?

[2 Marks]

Answer: The original number of chromosomes is restored in the progeny through the process of fertilization. In humans, each parent has 46 chromosomes in their body cells. However, during the formation of gametes (sperm and egg), the number of chromosomes is halved to 23 through a special type of cell division called meiosis. When the sperm and egg unite during fertilization, the 23 chromosomes from the sperm combine with the 23 chromosomes from the egg, restoring the full set of 46 chromosomes in the zygote. This process ensures that the offspring have the same chromosome number as their parents.

Key Points: Chromosomes in gametes are halved by meiosis-Fertilization combines 23 chromosomes from sperm and 23 chromosomes from egg-

Restores original 46 chromosomes in zygote-Maintains chromosome number from generation to generation

(4)

Explain by giving two examples of the organisms in which the sex is not genetically determined.

[2 Marks]

Answer: In some organisms, the sex is not determined genetically but by other factors. For example, in some reptiles, the sex of the offspring depends on the temperature at which the fertilised eggs are kept — this is known as temperature-dependent sex determination. Another example is snails, where individuals can change their sex during their lifetime, showing that sex is not fixed genetically in these organisms. Hence, these examples show that sex determination is not always genetically controlled.

Key Points: Sex not genetically determined-temperature affects sex in some reptiles-snails can change sex indicating sex is not fixed genetically

Question 29.

Many optical instruments consist of a number of lenses. They are combined to increase the magnification and sharpness of the image. The net power (P) of the lenses placed in contact is given by the algebraic sum of the powers of the individual lenses P_1, P_2, P_3 ... as

$P = P_1 + P_2 + P_3 ...$

This is also termed as the simple additive property of the power of lens, widely used to design lens systems of cameras, microscopes and telescopes. These lens systems can have a combination of convex lenses and also concave lenses.

(1)

What is the nature (convergent / divergent) of the combination of a convex lens of power +4 D and a concave lens of power -2 D?

[1 Marks]

Answer: The net power P of the combination is +4 D + (−2 D) = +2 D according to the case passage which states that powers add algebraically. Since the net power is

positive, the combination is convergent in nature. Thus, the lens combination acts like a convex lens.

Key Points: Net power is the algebraic sum of individual powers - Power of convex lens is positive - Power of concave lens is negative - Positive net power indicates convergent lens combination

(2)

Calculate the focal length of a lens of power -2.5 D.

[1 Marks]

Answer: The power P of a lens is related to its focal length f by the formula P = 1 / f, where f is in meters. Given the power P = -2.5 D, the focal length f = 1 / P = 1 / (-2.5) = -0.4 m. So, the focal length of the lens is -0.4 meters. This negative focal length indicates that the lens is concave, as mentioned in the case paragraph.

Key Points: Power P of lens is 1/focal length f - Given power is -2.5 D indicating a concave lens - Focal length f = 1/P = -0.4 meters

(3)

Draw a ray diagram to show the nature and position of an image formed by a convex lens of power +0.1 D, when an object is placed at a distance of 20 cm from its optical centre.

[2 Marks]

Answer: The power of the lens is +0.1 D, so its focal length f = 100 / P = 100 / 0.1 = 1000 cm. Since the object is at 20 cm, which is much less than the focal length, the object is placed between the optical centre and the focal point. In this case, the image formed by the convex lens is virtual, erect, and magnified, and it appears on the same side of the lens as the object. To draw the ray diagram, draw one ray parallel to the principal axis refracted through the focal point, and another passing through the optical centre without deviation. Their extensions meet on the same side of the lens, indicating the virtual image position.

Key Points: Power of lens +0.1 D means focal length 1000 cm - Object at 20 cm is between optical centre and focal point - Image formed is virtual, erect and

magnified on same side as object - Ray diagram rays refracted through focal point and undeviated through optical centre

(4)

How is a virtual image formed by a convex lens different from that formed by a concave lens ? Under what conditions do a convex and a concave lens form virtual images ?

[2 Marks]

Answer: A virtual image formed by a convex lens is erect, magnified and formed when the object is placed between the lens and its focal point. A concave lens always forms a virtual image that is erect and smaller than the object. The convex lens forms a virtual image only if the object is closer than the focal length, while a concave lens forms virtual images for all object positions. This difference is based on the lens types and is important in optical instruments as described in the case passage.

Key Points: Virtual image by convex lens is magnified and erect - Convex lens forms virtual image when object is inside focal length - Concave lens always forms smaller, erect, virtual images

Section E

Question 30.

A neutral organic compound 'X' (Molecular formula C_2H_6O) on reacting with acidified $K_2Cr_2O_7$ gives an organic compound 'Y' which is acidic in nature. 'X' reacts with 'Y' on warming in the presence of conc. H_2SO_4 to give a sweet smelling compound 'Z'.

(i) Identify 'X', 'Y' and 'Z'.

(ii) Write the chemical equations for the reactions in the conversion of (1) 'X' to 'Y' and (2) 'X' to 'Z'.

(iii) State the role of (1) acidified $K_2Cr_2O_7$ in the conversion of 'X' to 'Y' and (2) conc. H_2SO_4 in the reaction of 'X' and 'Y'.

(iv) Name the reaction which occurs when 'Z' reacts with an alkali.

[5 Marks]

Answer:

(i) Identification of compounds:

Compound 'X' with molecular formula C_2H_6O is ethanol (CH_3CH_2OH), a neutral organic compound. On reacting with acidified potassium dichromate ($K_2Cr_2O_7$), ethanol is oxidized to compound 'Y', which is ethanoic acid (CH_3COOH), an acidic compound. When ethanol (X) reacts with ethanoic acid (Y) in the presence of concentrated sulphuric acid (H_2SO_4) and heat, an esterification reaction occurs producing 'Z', which is ethyl ethanoate ($CH_3COOCH_2CH_3$), a sweet smelling ester.

(ii) Chemical equations:

1. Oxidation of ethanol (X) to ethanoic acid (Y):
$CH_3CH_2OH + 2[O] \rightarrow CH_3COOH + H_2O$
(where [O] represents the oxygen from acidified $K_2Cr_2O_7$)

2. Esterification reaction of ethanol (X) with ethanoic acid (Y) in presence of conc. H_2SO_4 to form ethyl ethanoate (Z):
$CH_3CH_2OH + CH_3COOH \rightleftharpoons CH_3COOCH_2CH_3 + H_2O$

(iii) Roles of reagents:

1. Acidified $K_2Cr_2O_7$ acts as an oxidizing agent in the oxidation of ethanol (X) to ethanoic acid (Y). It provides the necessary oxygen atoms for oxidation under acidic conditions.

2. Concentrated H_2SO_4 acts as a dehydrating agent and catalyst in the esterification reaction between ethanol and ethanoic acid, promoting the formation of the ester (Z) by removing water and shifting equilibrium towards ester formation.

(iv) Reaction of 'Z' with alkali:

When the ester (ethyl ethanoate, Z) reacts with an alkali such as sodium hydroxide (NaOH), a saponification reaction occurs, producing an alcohol and a salt of the acid (sodium ethanoate).

Question 31.

Carry out the following conversions, stating the condition(s) for each:

(i) Ethanol ⟶ Ethene

(ii) Ethene ⟶ Ethane

(iii) Ethane ⟶ Chloroethane

(iv) Ethanol ⟶ Ethanoic acid

(v) Ethanoic acid ⟶ Ethyl ethanoate

[5 Marks]

Answer:

(i) Ethanol to Ethene:

Ethanol when heated with concentrated sulfuric acid (H_2SO_4) at around 170°C undergoes dehydration to form ethene and water. The reaction removes water (H_2O) from ethanol.

(ii) Ethene to Ethane:

Ethene is converted to ethane by hydrogenation, which involves addition of hydrogen (H_2) in the presence of a catalyst such as nickel (Ni) at elevated temperature and pressure.

(iii) Ethane to Chloroethane:

Ethane reacts with chlorine (Cl_2) in the presence of sunlight (UV light) to undergo substitution and form chloroethane and hydrogen chloride. This is a free radical substitution reaction.

(iv) Ethanol to Ethanoic acid:

When ethanol is oxidized by an oxidizing agent like potassium dichromate ($K_2Cr_2O_7$) in acidic medium (dilute sulfuric acid), ethanol is first converted to acetaldehyde and then further oxidized to ethanoic acid (acetic acid).

(v) Ethanoic acid to Ethyl ethanoate:

Ethanoic acid reacts with ethanol in the presence of an acid catalyst (usually concentrated sulfuric acid) under reflux to form ethyl ethanoate through an esterification reaction. This reaction is reversible.

Question 32.

(i) Where are testes located in the human males and why ? State two function of the testes.

(ii) In the human female, one of the ovaries releases an egg every month. State the changes that take place if

(1) the egg is fertilized, and

(2) the egg is not fertilized.

(iii) What is done during the surgical method in males and females to prevent pregnancy ?

[5 Marks]

Answer:

(i) In human males, the testes are located in the scrotum, which is outside the body. They are positioned outside the abdominal cavity because sperm production requires a temperature slightly lower than the normal body temperature. The two main functions of the testes are: to produce sperm cells, which are male reproductive cells, and to produce the male hormone testosterone that controls the development of male secondary sexual characteristics like hair growth and muscle development.

(ii) Changes in the female body after ovulation:

(1) If the egg is fertilized, it travels to the uterus and gets implanted in the uterine lining. This leads to the formation of an embryo and the female body begins to produce hormones to maintain the pregnancy.

(2) If the egg is not fertilized, it does not get implanted. The uterine lining breaks down and is shed along with the unfertilized egg as menstruation.

(iii) To prevent pregnancy through surgical methods, in males, vasectomy is performed where the sperm ducts are cut and tied to stop the passage of sperm. In females, tubectomy is done where the fallopian tubes are cut and tied to prevent the egg from traveling to the uterus, thus preventing fertilization.

Question 33.

(i) What happens when :

(1) Leaves of Bryophyllum fall on the soil ?

(2) Planaria is cut into many pieces ?

(3) Sporangia of Rhizopus on maturation liberate spores ? Mention the modes of reproduction in each of the above three cases.

(ii) Write the changes that occur in a flower once the fertilisation has taken place.

[5 Marks]

Answer:

(i) (1) When leaves of Bryophyllum fall on the soil, small plantlets develop from the edges of the leaves. These plantlets grow into new plants. This is an example of vegetative reproduction where new plants grow from parts of the parent plant.

(2) When Planaria is cut into many pieces, each piece can regenerate and grow into a complete new Planaria. This is called regeneration, a type of asexual reproduction.

(3) When the sporangia of Rhizopus mature, they burst open and release numerous spores into the environment. These spores germinate and grow into new Rhizopus fungi. This is reproduction by spores.

Therefore, Bryophyllum reproduces by vegetative propagation, Planaria by regeneration, and Rhizopus by spore formation.

(ii) After fertilisation in a flower, several changes occur: The zygote formed develops into an embryo, the ovule transforms into a seed containing the embryo, and the ovary changes into a fruit which protects the seed and aids in its dispersal. Other floral parts like petals, sepals, and stamens usually wither and fall off as their functions are complete.

Question 34.

(a) State Ohm's Law.

(b) Name and define the physical quantity determined by the slope of V–I curve given in the diagram. Use this graph to find the value of this physical quantity in SI units.

(c) Establish the relationship between 1 kWh and 1 joule.

[5 Marks]

Answer: **(a)** Ohm's Law states that the potential difference V across a conductor is directly proportional to the current I flowing through it, provided the temperature remains constant. Mathematically, V = IR, where R is the resistance.
(b) The physical quantity determined by the slope of the V-I curve is the resistance (R). Resistance is defined as the ratio of voltage V to current I, R = V / I. To find R from the graph, take two points on the line, calculate the change in voltage and current, then divide. For example, if V = 6 volts and I = 2 amperes from the graph, then R = 6 / 2 = 3 ohms (Ω).
(c) Relationship between 1 kWh and 1 joule: 1 kilowatt hour (kWh) is the energy consumed by a 1000 watt device running for 1 hour. Since 1 hour = 3600 seconds, 1 kWh = 1000 watts * 3600 seconds = 3,600,000 joules. Therefore, 1 kWh = $3.6 * 10^6$ joules.