CBSE 2023 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]

In the experimental setup given below, it is observed that on passing the gas produced in the reaction in the solution 'X', the solution 'X' first turns milky and then colourless. The option that justifies the above stated observation is that 'X' is aqueous calcium hydroxide and

(a) it turns milky due to carbon dioxide gas liberated in the reaction and after sometime it becomes colourless due to formation of calcium carbonate.

(b) it turns milky due to formation of calcium carbonate and on passing excess of carbon dioxide it becomes colourless due to formation of calcium hydrogen carbonate which is soluble in water. <<

(c) it turns milky due to passing of carbon dioxide through it. It turns colourless as on further passing carbon dioxide, sodium hydrogen carbonate is formed which is soluble in water.

(d) the carbon dioxide liberated during the reaction turns lime water milky due to formation of calcium hydrogen carbonate and after some time it turns colourless due to formation of calcium carbonate which is soluble in water.

Explanation:

When CO_2 is passed through lime water ($Ca(OH)_2$), it first forms insoluble $CaCO_3$ (milky).

On passing excess CO_2, soluble $Ca(HCO_3)_2$ is formed, making it colourless.

Q.2 [1 mark]

The emission of brown fumes in the given experimental set-up is due to

(a) thermal decomposition of lead nitrate which produces brown fumes of nitrogen dioxide. <<

(b) thermal decomposition of lead nitrate which produces brown fumes of

lead oxide.

(c) oxidation of lead nitrate forming lead oxide and nitrogen dioxide.

(d) oxidation of lead nitrate forming lead oxide and oxygen.

Explanation:

When lead nitrate is heated, it decomposes to form lead oxide (yellow), nitrogen dioxide (brown fumes) and oxygen: 2Pb(NO3)2 -> 2PbO + 4NO2 + O2.

Q.3 [1 mark]

$MnO_2 + x\ HCl \rightarrow MnCl_2 + y\ H_2O + z\ Cl_2$

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

(a) 6, 2, 2

(b) 4, 1, 2

(c) 4, 2, 1 <<

(d) 2, 2, 1

Explanation:

The balanced equation is MnO2 + 4HCl -> MnCl2 + 2H2O + Cl2, so x=4, y=2, z=1.

Q.4 [1 mark]

The table below has information regarding pH and the nature (acidic/basic) of four different solutions. Which one of the options in the table is correct?

(a) Lemon juice | Orange pH paper | pH 3 | Basic

(b) Milk of magnesia | Blue pH paper | pH 10 | Basic

(c) Gastric juice | Red pH paper | pH 6 | Acidic

(d) Pure water | Yellow pH paper | pH 7 | Neutral

(a) Lemon juice, Orange pH paper, pH 3, Basic

(b) Milk of magnesia, Blue pH paper, pH 10, Basic <<

(c) Gastric juice, Red pH paper, pH 6, Acidic

(d) Pure water, Yellow pH paper, pH 7, Neutral

Explanation:

Milk of magnesia is basic (pH ~10).

It would turn pH paper blue.

Lemon juice is acidic (not basic), gastric juice has pH ~1.5 (not 6), and pure water is neutral but turns pH paper green (not yellow).

Q.5 [1 mark]

A metal 'X' is used in thermite process. When X is burnt in air it gives an amphoteric oxide 'Y'. 'X' and 'Y' are respectively:

(a) Fe and Fe2O3

(b) Al and Al2O3 <<

(c) Fe and Fe3O4

(d) Al and Al3O4

Explanation:

Aluminium (Al) is used in the thermite process.

When burnt in air, it forms aluminium oxide (Al2O3), which is amphoteric in nature.

Q.6 [1 mark]

Select washing soda from the following:

(a) NaHCO3

(b) Na2CO3.5H2O

(c) Na2CO3.10H2O <<

(d) NaOH

Explanation:

Washing soda is sodium carbonate decahydrate, Na2CO3.10H2O.

Q.7 [1 mark]

Consider the structures of the three cyclic carbon compounds A, B and C given below and select the correct option from the following:

(a) A and C are isomers of hexane and B is benzene.

(b) A is an isomer of hexane, B is benzene and C is an isomer of hexene.

(c) A is a saturated cyclic hydrocarbon and B and C are unsaturated cyclic hydrocarbons. <<

(d) A is cyclohexane and B and C are the isomers of benzene.

Explanation:

A (cyclohexane) has only single bonds, so it is a saturated cyclic hydrocarbon.

B (benzene) and C (two double bonds in the ring, drawn in the paper) have double bonds, so both are unsaturated cyclic hydrocarbons.

So (c).

Q.8 [1 mark]

An organism which breaks down the food material outside the body and then absorbs it is

(a) a plant parasite, Cuscuta

(b) an animal parasite, Tapeworm

(c) a bacteria, Rhizobium

(d) a fungi, Rhizopus <<

Explanation:

Rhizopus (a fungus) secretes digestive enzymes outside its body onto the food material, breaks it down, and then absorbs the nutrients.

This is called saprophytic nutrition.

Q.9 [1 mark]

Consider the following statements about small intestine and select the one which is NOT correct:

(a) The length of the small intestine in animals differs as it depends on the type of food they eat.

(b) The small intestine is the site of complete digestion of food.

(c) The small intestine receives secretions from liver and pancreas.

(d) The villi of the small intestine absorb water from the unabsorbed food before it gets removed from the body via the anus. <<

Explanation:

The villi of the small intestine absorb digested nutrients, not water from unabsorbed food.

Water absorption from undigested food occurs primarily in the large intestine.

Q.10 [1 mark]

The statement that correctly describes the characteristic(s) of a gene is:

(a) In individuals of a given species, a specific gene is located on a particular chromosome. <<

(b) A gene is not the information source for making proteins in the cell.

(c) Each chromosome has only one gene located all along its length.

(d) All the inherited traits in human beings are not controlled by genes.

Explanation:

In individuals of a given species, a specific gene is located on a particular chromosome at a specific locus.

Genes do code for proteins, chromosomes have many genes, and inherited traits are controlled by genes.

Q.11 [1 mark]

Select from the following the correct statement about tropic movement in plants:

(a) It is due to stimulus of touch and temperature.

(b) It does not depend upon the direction of stimulus received.

(c) It is observed only in roots and not in stems.

(d) It is a growth related movement. <<

Explanation:

Tropic movements are growth-related directional movements in plants in response to stimuli like light, gravity, water, etc.

They depend on the direction of stimulus and occur in both roots and stems.

Q.12 [1 mark]

Select the INCORRECT match (between the plant and its vegetative part)

from the following:

(a) Bryophyllum, leaf
(b) Potato, stem
(c) Money-plant, stem
(d) Rose, root <<

Explanation:

Rose propagates vegetatively through stem cuttings, not roots.
Bryophyllum propagates through leaf buds, potato through stem tubers, and money plant through stem cuttings.

Q.13 [1 mark]

If four identical resistors, of resistance 8 ohm, are first connected in series so as to give an effective resistance Rs, and then connected in parallel so as to give an effective resistance Rp, then the ratio Rs/Rp is

(a) 32
(b) 2
(c) 0.5
(d) 16 <<

Explanation:

Rs = 4 x 8 = 32 ohm (series). Rp = 8/4 = 2 ohm (parallel). Rs/Rp = 32/2 = 16.

Q.14 [1 mark]

In domestic electric circuits the wiring with 15 A current rating is for the electric devices which have

(a) higher power ratings such as geyser. <<
(b) lower power ratings such as fan.
(c) metallic bodies and low power ratings.
(d) non-metallic bodies and low power ratings.

Explanation:

15 A current rating wiring is used for high power electrical appliances like geysers, air

conditioners, etc.

Lower power devices like fans and bulbs use 5 A wiring.

Q.15 [1 mark]

In the following diagram, the position of the needle is shown on the scale of a voltmeter. The least count of the voltmeter and the reading shown by it respectively are:

(a) 0.15 V and 1.6 V

(b) 0.05 V and 1.6 V <<

(c) 0.15 V and 1.8 V

(d) 0.05 V and 1.8 V

Explanation:

The voltmeter scale goes from 0 to 3V with markings at 1.5V.

Each small division = (3-0)/60 = 0.05V (least count).

The needle points to 1.6V.

Q.16 [1 mark]

The resultant magnetic field at point 'P' situated midway between two parallel wires (placed horizontally) each carrying a steady current I is

(a) in the same direction as the current in the wires.

(b) in the vertically upward direction.

(c) zero <<

(d) in the vertically downward direction.

Explanation:

When two parallel wires carry current in the same direction, the magnetic fields at the midpoint P are equal in magnitude but opposite in direction (one points up, the other down), so they cancel out giving zero resultant field.

Q.17 [1 mark]

Assertion (A): The colour of aqueous solution of copper sulphate turns colourless when a piece of lead is added to it.

Reason (R): Lead is more reactive than copper, and hence displaces copper from its salt solution.

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

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

Explanation:
Lead is placed above copper in the reactivity series, so (R) is true.
Whether (A) counts as true (colour fading as Cu is displaced) is arguable because lead sulphate is insoluble and coats the lead;
the stored key (d) needs checking against the official marking scheme.
Note: this answer could not be confirmed against an official CBSE marking scheme.

Q.18 [1 mark]

Assertion (A): Genes inherited from the parents decide the sex of a child.
Reason (R): X chromosome in a male child is inherited from his father.

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

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

Explanation:

Assertion is true - genes (sex chromosomes) determine the sex of a child.

Reason is false - in a male child (XY), the X chromosome comes from the mother, not the father.

The father contributes the Y chromosome.

Q.19 [1 mark]

Assertion (A): Blood clotting prevents excessive loss of blood.

Reason (R): Blood clotting is due to blood plasma and white blood cells present in the blood.

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

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

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

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

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

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

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

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

Explanation:

Assertion is true - blood clotting does prevent excessive blood loss.

Reason is false - blood clotting is due to platelets (thrombocytes), not WBCs and plasma.

Q.20 [1 mark]

Assertion (A): The strength of the magnetic field produced at the centre of a current carrying circular coil increases on increasing the number of turns in it.

Reason (R): The current in each circular turn has the same direction and the magnetic field due to each turn then just adds up.

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

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

Explanation:
Both assertion and reason are true.
The magnetic field at the centre of a circular coil is directly proportional to the number of turns.
Since current flows in the same direction in each turn, the magnetic fields due to individual turns add up, correctly explaining the assertion.

Q.21(a) [2 marks]

(a) (i) A compound 'X' which is prepared from gypsum has the property of hardening when mixed with proper quantity of water. Identify 'X' and write its chemical formula.
(ii) State the difference in chemical composition between baking soda and baking powder.

Answer: (i) X is Plaster of Paris (POP). Chemical formula: $CaSO_4.1/2\ H_2O$ (Calcium sulphate hemihydrate).
(ii) Baking soda is sodium hydrogen carbonate ($NaHCO_3$) only. Baking powder is a mixture of baking soda ($NaHCO_3$) and a mild edible acid such as tartaric acid.

Explanation:
Plaster of Paris is prepared by heating gypsum ($CaSO_4.2H_2O$) at 373 K.
It hardens when mixed with water by forming gypsum again.

OR

Q.21(a) [2 marks]

(OR) Write balanced chemical equation for the reaction that occurs when:
(i) blue coloured copper sulphate crystals are heated and
(ii) Sodium hydrogen carbonate is heated during cooking.

Answer: (i) $CuSO_4.5H_2O \xrightarrow{heat} CuSO_4 + 5H_2O$ (Blue crystals turn white/colourless)
(ii) $2NaHCO_3 \xrightarrow{heat} Na_2CO_3 + H_2O + CO_2$

Explanation:
Heating hydrated copper sulphate removes water of crystallisation turning it from blue to white.
Sodium hydrogen carbonate decomposes on heating to form sodium carbonate, water and carbon dioxide.

Q.22(a) [2 marks]

(a) Write the role of insulin in regulating blood sugar levels in human body. Mention the disease caused due to it.

Answer: Insulin is a hormone produced by the pancreas (beta cells of Islets of Langerhans). It regulates blood sugar level by converting excess glucose in the blood into glycogen, which is stored in the liver. The disease caused due to deficiency of insulin is Diabetes (Diabetes mellitus).

Explanation:
Insulin lowers blood sugar by promoting glucose uptake by cells and glycogen storage.
Its deficiency leads to diabetes mellitus.

Q.22(b) [2 marks]

(b) How is the timing and the amount of release of insulin in the blood regulated?

Answer: The timing and amount of insulin release is regulated by a feedback mechanism. When blood sugar rises (e.g., after a meal), it stimulates the beta cells of the pancreas to secrete more insulin. When blood sugar falls to normal levels, insulin secretion is reduced. This is an example of negative feedback

regulation.

Explanation:

Blood sugar levels are regulated by a feedback mechanism involving insulin from the pancreas.

Q.23(a) [2 marks]

(a) Name the type of blood (oxygenated / deoxygenated) transported by each of the following mentioning the path (i.e. from one organ (which place) to another (which place)).

(i) Vena cava

(ii) Pulmonary artery

Answer: (i) Vena cava carries deoxygenated blood from all parts of the body to the right atrium of the heart.

(ii) Pulmonary artery carries deoxygenated blood from the right ventricle of the heart to the lungs.

Explanation:

Vena cava and pulmonary artery both carry deoxygenated blood but to different destinations.

This is an exception where an artery carries deoxygenated blood.

OR

Q.23(a) [2 marks]

(OR) With the help of a schematic flow chart, show the breakdown of glucose in a cell to provide energy -

(i) in the presence of oxygen

(ii) in lack of oxygen

Answer: Glucose (6-carbon) --Cytoplasm--> Pyruvate (3-carbon) + Energy

(i) In presence of oxygen (Aerobic): Pyruvate --Mitochondria--> CO_2 + H_2O + Energy (ATP)

(ii) In lack of oxygen (Anaerobic):

- In yeast: Pyruvate ---> Ethanol + CO_2 + Energy

- In muscles: Pyruvate ---> Lactic acid + Energy

Explanation:

Glucose is first broken down into pyruvate in the cytoplasm.

In the presence of oxygen, pyruvate enters mitochondria for complete oxidation.

In the absence of oxygen, fermentation occurs.

Section B

Very Short Answer Questions (2 marks each)

Q.24 [2 marks]

Name the part of the human excretory system where nephrons are found. Write the structure and function of nephrons.

Answer: Nephrons are found in the kidneys.

Structure: Each nephron has two parts:

1. Bowman's capsule (Malpighian body) - a cup-shaped structure containing a bundle of capillaries called glomerulus.

2. Tubular part - consisting of proximal convoluted tubule, loop of Henle, and distal convoluted tubule, which leads to a collecting duct.

Function: Nephrons are the basic filtration units of the kidney. They filter the blood to remove waste products (urea, uric acid, excess salts and water) and form urine. The process involves ultrafiltration, selective reabsorption, and tubular secretion.

Explanation:

Nephrons are the structural and functional units of the kidney responsible for filtering blood and forming urine.

Q.25(a) [2 marks]

(a) A narrow beam XY of white light is passing through a glass prism ABC as

shown in the diagram. Trace it on your answer sheet and show the path of the emergent beam as observed on the screen PQ. Name the phenomenon observed and state its cause.

Answer: The phenomenon is Dispersion of light. The emergent beam splits into a band of seven colours (spectrum) - VIBGYOR (Violet, Indigo, Blue, Green, Yellow, Orange, Red) on screen PQ, with violet deviating the most and red the least.

Cause: Different colours of light have different wavelengths. When white light passes through a prism, each colour is refracted by a different angle because the refractive index of glass is different for different wavelengths. Shorter wavelengths (violet) are refracted more than longer wavelengths (red).

Explanation:

White light disperses into its component colours when passing through a prism due to different refractive indices for different wavelengths.

OR

Q.25(a) [2 marks]

(OR) (b) It is observed that the power of an eye to see nearby objects as well as far off objects diminishes with age.

(i) Give reason for the above statement.

(ii) Name the defect that is likely to arise in the eyes in such a condition.

(iii) Draw a labelled ray diagram to show the type of corrective lens used for restoring the vision of such an eye.

Answer: (i) With age, the ciliary muscles weaken and the eye lens becomes inflexible/rigid, losing its ability to adjust its focal length (power of accommodation decreases). This makes it difficult to see both nearby and far off objects clearly.

(ii) The defect is called Presbyopia.

(iii) Presbyopia is corrected using bifocal lenses - the upper part is a concave lens (for distant vision) and the lower part is a convex lens (for near vision). Sometimes progressive lenses are also used.

Explanation:

Presbyopia is an age-related condition where the eye loses its power of accommodation, corrected using bifocal lenses.

Q.26 [2 marks]

How do harmful chemicals get accumulated progressively at each trophic level in a food chain?

Answer: This process is called Biological Magnification (Biomagnification).

When harmful chemicals (like pesticides, DDT, mercury) enter a food chain, they are non-biodegradable and cannot be broken down by biological processes. At each trophic level, organisms consume many organisms of the lower trophic level. Since these chemicals are not excreted or metabolized, they accumulate in the body tissues of organisms. As we move to higher trophic levels, the concentration of these chemicals increases progressively because:

1. Organisms at higher levels eat many organisms from lower levels.
2. The chemicals get concentrated at each successive level.
3. The maximum concentration is found in top consumers (tertiary consumers).

Explanation:

Biological magnification causes non-biodegradable pollutants to increase in concentration at each successive trophic level in a food chain.

Section C

Short Answer Questions (3 marks each)

Q.27 [3 marks]

(a) Identify the reducing agent in the following reactions:

(i) $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

(ii) $H_2O + F_2 \rightarrow HF + HOF$

(iii) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

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

(b) Define a redox reaction in terms of gain or loss of oxygen.

Answer: (a) Reducing agents:

(i) NH_3 (ammonia) — it is oxidised (gains oxygen to form NO)

(ii) H_2O (water) — it is oxidised by F_2 (oxygen goes from −2 in H_2O to 0 in HOF)

(iii) CO (carbon monoxide) — it gains oxygen to form CO_2

(iv) H_2 (hydrogen) — it gains oxygen to form H_2O

(b) A redox reaction is a reaction in which one substance is oxidised (gains oxygen) while another is reduced (loses oxygen) at the same time. For example, in (iii), CO gains oxygen (oxidised) and Fe_2O_3 loses oxygen (reduced).

Explanation:

A reducing agent is the substance that is oxidised, i.e.
it gains oxygen (or loses hydrogen/electrons) and reduces the other reactant.
In each reaction the species oxidised is NH_3, H_2O, CO and H_2 respectively.
A redox reaction involves simultaneous oxidation and reduction.

Q.28 [3 marks]

(a) Suggest one remedial measure each to counteract the change in pH in human beings in following cases:

(i) Production of too much acid in stomach during indigestion

(ii) Stung by a honey bee / nettle leaves

(b) Fresh milk has a pH of 6. When it changes into curd will its pH increase or decrease? Why?

Answer: (a) (i) During indigestion (excess acid in stomach), an antacid (mild base) such as milk of magnesia (Mg(OH)2) or baking soda (NaHCO3) is taken to neutralise the excess acid.

(ii) For honey bee sting / nettle leaves sting (which inject methanoic acid / formic acid), a mild base like baking soda (sodium hydrogen carbonate) solution should be applied to neutralise the acid.

(b) The pH will decrease (become more acidic). When milk changes into curd, the lactose (milk sugar) is converted into lactic acid by the action of Lactobacillus bacteria. The production of lactic acid makes the curd more acidic, so pH decreases below 6.

Explanation:

Antacids neutralise excess stomach acid.

Bases neutralise bee sting acid.

Curd formation produces lactic acid, lowering pH.

Q.29(a) [3 marks]

(a) (i) State the role of ATP in cellular respiration.

(ii) What ensures sufficient exchange of gases in plants?

(iii) State the conditions on which the direction of diffusion of gases in plant depend upon.

Answer: (i) ATP (Adenosine Triphosphate) is the energy currency of the cell. During cellular respiration, the energy released from the breakdown of glucose is stored in the form of ATP molecules. This ATP is used to fuel various cellular activities like muscle contraction, nerve impulse transmission, biosynthesis, etc.

(ii) In plants, sufficient exchange of gases is ensured by the presence of stomata on leaves and lenticels on stems. The large surface area of leaves with numerous stomata allows efficient gas exchange. Also, plant cells are not located far from the surface, which reduces the need for a specialised transport system for gases.

(iii) The direction of diffusion of gases depends upon:

- The environmental conditions surrounding the plant
- The requirement of the plant (photosynthesis during day / respiration at night)
- The concentration gradient of gases (CO_2 and O_2) between the plant cells and the atmosphere.

Explanation:

ATP stores energy from respiration.

Stomata and lenticels enable gas exchange.

Diffusion direction depends on concentration gradients and plant needs.

OR

Q.29(a) [3 marks]

(OR) (a) (i) What is the internal energy reserve in plants and animals?

(ii) How do desert plants perform photosynthesis if their stomata remain closed during the day?

Answer: (i) The internal energy reserve in plants is starch. The internal energy reserve in animals is glycogen.

(ii) Desert plants take up CO_2 at night when the stomata open. The stomata remain closed during the day to prevent water loss by transpiration. The CO_2 taken in at night is stored in the form of an intermediate (such as organic acids). During the day, this stored CO_2 is used for photosynthesis even with closed stomata. This is a special type of photosynthesis called CAM (Crassulacean Acid Metabolism).

Explanation:

Plants store energy as starch, animals as glycogen.

Desert plants open stomata at night to take in CO_2 and use it for photosynthesis during the day.

Q.30 [3 marks]

(a) Complete the following ray diagram to show the formation of image. (Figure: a convex mirror, object AB in front of the pole P; Ray 1 from A runs parallel to the principal axis; Ray 2 from A is directed towards the centre of curvature C; R lies midway between P and C, i.e. at the principal focus F.)

(b) Mention the nature, position and size of the image formed in this case.

(c) State the sign of the image distance in this case using the Cartesian sign

convention.

Answer: (a) The mirror in the figure is convex (its centre of curvature C lies behind the reflecting surface).

- Ray 1 (parallel to the principal axis) is reflected so that it appears to come from the principal focus F behind the mirror (draw the reflected ray going away from the mirror, with its backward extension dashed through F).
- Ray 2 (directed towards C) is reflected back along the same path.

The two reflected rays diverge; extended backwards (dashed) they meet behind the mirror, between P and F, where the image A'B' is drawn, upright.

(b) Nature: virtual and erect. Position: behind the mirror, between the pole P and the focus F. Size: diminished (smaller than the object).

(c) The image distance is positive, because the image is formed behind the mirror, on the side opposite to the incident light.

Explanation:

A convex mirror always forms a virtual, erect and diminished image behind the mirror between P and F.

Image distance v is positive by the Cartesian sign convention.

Q.31 [3 marks]

Give reasons for the following:

(a) Danger signals installed at airports and at the top of tall buildings are of red colour.

(b) The sky appears dark to the passengers flying at very high altitudes.

(c) The path of a beam of light passing through a colloidal solution is visible.

Answer: (a) Red colour is used for danger signals because red light has the longest wavelength among visible colours. It is scattered the least by fog, smoke, and atmospheric particles, so it can be seen from the farthest distance.

(b) At very high altitudes, the atmosphere is very thin with very few air molecules to scatter sunlight. Since there is almost no scattering of light, the sky appears dark/black to passengers flying at high altitudes.

(c) The path of a beam of light is visible in a colloidal solution due to the Tyndall effect. The particles of a colloid are large enough to scatter light. When a beam of light passes through a colloidal solution, the colloidal particles scatter the light, making the path of the beam visible.

Explanation:
Red light scatters least (longest wavelength).
At high altitudes, minimal scattering makes sky dark.
Tyndall effect makes light visible in colloids.

Q.32(a) [3 marks]

(a) (i) State the rule used to find the force acting on a current carrying conductor placed in a magnetic field.
(ii) Given below are three diagrams showing entry of an electron in a magnetic field. Identify the case in which the force will be (1) maximum and (2) minimum respectively. Give reason for your answer.
[Diagram (i) shows electron entering perpendicular to field, (ii) at an angle, (iii) parallel to field]

Answer: (i) 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 current (I), then the thumb gives the direction of force (F) on the conductor.

(ii) (1) Maximum force: Case (i) - when the electron enters perpendicular to the magnetic field (angle = 90 degrees). F = qvB sin(theta), and sin 90 = 1, giving maximum force.

(2) Minimum force: Case (iii) - when the electron enters parallel to the magnetic field (angle = 0 degrees). F = qvB sin(0) = 0, giving zero (minimum) force.

Explanation:

Fleming's Left Hand Rule gives force direction.

Force on a charged particle is maximum when it moves perpendicular to the field and zero when parallel.

OR

Q.32(a) [3 marks]

(OR) (a) Draw the pattern of magnetic field lines of

(i) a current carrying solenoid

(ii) a bar magnet

(b) List two distinguishing features between the two fields.

Answer: (a) (i) A current carrying solenoid produces magnetic field lines similar to a bar magnet. Inside the solenoid, the field lines are parallel and uniform, running from south to north pole inside. Outside, they curve from north to south pole.

(ii) A bar magnet has field lines emerging from the north pole and entering the south pole outside the magnet, forming closed loops.

(b) Two distinguishing features:

1. The magnetic field of a solenoid can be varied by changing the current or the number of turns, while the field of a bar magnet is fixed/permanent.

2. The polarity of a solenoid can be reversed by reversing the direction of current, while the polarity of a bar magnet cannot be changed.

Explanation:

Both produce similar field patterns, but solenoid field is controllable and reversible while bar magnet field is permanent.

Q.33(a) [3 marks]

(a) (i) Why does a kitchen garden called an artificial ecosystem while a forest is considered to be a natural ecosystem?

(ii) While designing an artificial ecosystem at home, write any two things to be kept in mind to convert it into a self-sustaining system. Give reason to justify your answer.

Answer: (i) A kitchen garden is an artificial ecosystem because it is created, maintained and managed by humans. The plants grown, watering schedule, and pest control are all human-controlled. A forest is a natural ecosystem because it exists and functions naturally without human intervention. It is self-sustaining with natural processes of energy flow, nutrient cycling, and ecological balance.

(ii) Two things to keep in mind:

1. Include organisms from all trophic levels (producers, consumers, decomposers) - This ensures proper energy flow and nutrient cycling in the ecosystem.

2. Ensure proper balance between the number of organisms at each trophic level - This maintains the ecological balance and prevents overpopulation or extinction of any species in the system.

Explanation:

Artificial ecosystems are human-managed while natural ones are self-sustaining.

A self-sustaining system needs all trophic levels and ecological balance.

OR

Q.33(a) [3 marks]

(OR) (b) Construct a food chain of four trophic levels comprising the following: Hawk, snake, plants, rat.

(c) 20,000 J of energy was transferred by the producers to the organisms of second trophic level. Calculate the amount of energy that will be transferred by organisms of the third trophic level to the organisms of the fourth trophic level.

Answer: (b) Food chain: Plants -> Rat -> Snake -> Hawk

(Producers -> Primary consumer -> Secondary consumer -> Tertiary consumer)

(c) According to the 10% law of energy transfer:

- Energy at 2nd trophic level (primary consumers) = 20,000 J
- Energy at 3rd trophic level = 10% of 20,000 = 2,000 J
- Energy transferred from 3rd to 4th trophic level = 10% of 2,000 = 200 J

Therefore, 200 J of energy will be transferred to the organisms of the fourth trophic level.

Explanation:

In a food chain, only 10% of energy is transferred to the next trophic level (Lindeman's 10% law).

Q.34(a) [5 marks]

(a) A saturated organic compound 'A' belongs to the homologous series of alcohols. On heating 'A' with concentrated sulphuric acid at 443 K, it forms an unsaturated compound 'B' with molecular mass 28 u. The compound 'B' on addition of one mole of hydrogen in the presence of Nickel, changes to a saturated hydrocarbon 'C'.

(i) Identify A, B and C.

(ii) Write the chemical equations showing the conversion of A into B.

(iii) What happens when compound C undergoes combustion?

(iv) State one industrial application of hydrogenation reaction.

(v) Name the products formed when compound A reacts with sodium.

Answer: (i) A = Ethanol (C_2H_5OH), B = Ethene/Ethylene (C_2H_4, molecular mass = 28u), C = Ethane (C_2H_6)

(ii) $C_2H_5OH \xrightarrow{\text{conc.}H_2SO_4,\ 443K} C_2H_4 + H_2O$

(Ethanol undergoes dehydration to form ethene)

(iii) When ethane (C) undergoes combustion:

$C_2H_6 + 7/2\ O_2 \rightarrow 2CO_2 + 3H_2O$ + Heat and Light

(or 2C2H6 + 7O2 -> 4CO2 + 6H2O)
It burns with a blue flame producing CO2 and water.

(iv) Hydrogenation is used in the conversion of vegetable oils (unsaturated fats/liquid) to vegetable ghee/vanaspati (saturated fats/solid). This is used in the food industry.

(v) When ethanol reacts with sodium:
2C2H5OH + 2Na -> 2C2H5ONa + H2 (gas)
Products: Sodium ethoxide and hydrogen gas.

Explanation:
Ethanol dehydrates to ethene (28u), which hydrogenates to ethane.
Hydrogenation is used industrially to make vanaspati ghee.

OR

Q.34(a) [5 marks]

(OR) (b) (i) With the help of diagram, show the formation of micelles, when soap is applied on oily dirt.
(ii) Take two test tubes X and Y with 10 mL of hard water in each. In test tube 'X', add few drops of soap solution and in test tube 'Y' add a few drops of detergent solution. Shake both the test tubes for the same period.
(1) In which test tube the formation of foam will be more? Why?
(2) In which test tube is a curdy solid formed? Why?

Answer: (i) Micelle formation: When soap is applied on oily dirt, the soap molecules arrange themselves in a cluster called micelle. The hydrophobic (non-polar) tail of the soap molecule dissolves in the oil/grease, while the hydrophilic (ionic/polar) head remains in water. The oily dirt gets trapped in the centre of the micelle with the hydrocarbon tails pointing inwards and ionic heads pointing outwards into water. This allows the oily dirt to be washed away with water.

(ii) (1) Test tube Y (with detergent) will have more foam formation. This is because detergents work effectively in both hard and soft water. Detergents do not react with calcium and magnesium salts present in hard water, so they produce lather easily.

(2) Test tube X (with soap) will have a curdy solid (scum) formed. This is because soap reacts with calcium and magnesium ions present in hard water to form insoluble calcium/magnesium stearate (scum): 2C17H35COONa + CaCl2 -> (C17H35COO)2Ca + 2NaCl

Explanation:
Soap forms micelles to clean oily dirt.
In hard water, soap forms scum (insoluble salts) while detergent works effectively.

Section D

Long Answer Questions (5 marks each)

Q.35 [5 marks]

(a) Name the parts of a bisexual flower that are not directly involved in reproduction.

(b) Differentiate between self pollination and cross pollination. List any two significance of pollination.

(c) What is the fate of ovules and ovary after fertilization in a flower?

Answer: (a) The parts of a bisexual flower not directly involved in reproduction are:
- Sepals (calyx) - They protect the flower bud.
- Petals (corolla) - They attract pollinators with their colour and fragrance.

(b) Differences:
Self pollination: Transfer of pollen grains from the anther to the stigma of the same flower or another flower on the same plant.
Cross pollination: Transfer of pollen grains from the anther of one flower to the

stigma of another flower on a different plant of the same species.

Two significances of pollination:

1. It leads to fertilization and production of seeds and fruits.

2. Cross pollination introduces genetic variation in the offspring, which helps in evolution and adaptation.

(c) After fertilization:

- Ovules develop into seeds.
- Ovary develops into fruit (which encloses the seeds).

Explanation:

Sepals and petals are non-reproductive parts.

Self pollination is within same plant, cross pollination between different plants.

Ovules become seeds, ovary becomes fruit.

Q.36 [5 marks]

(a) An electric iron consumes energy at a rate of 880 W when heating is at the maximum rate and 330 W when the heating is at the minimum. If the source voltage is 220 V, calculate the current and resistance in each case.

(b) What is heating effect of electric current?

(c) Find an expression for the amount of heat produced when a current passes through a resistor for some time.

Answer: (a) At maximum heating (P = 880 W, V = 220 V):

Current I = P/V = 880/220 = 4 A

Resistance R = V/I = 220/4 = 55 ohm (or R = V^2/P = 220^2/880 = 55 ohm)

At minimum heating (P = 330 W, V = 220 V):

Current I = P/V = 330/220 = 1.5 A

Resistance R = V/I = 220/1.5 = 146.67 ohm (or R = V^2/P = 220^2/330 = 146.67 ohm)

(b) Heating effect of electric current: When an electric current flows through a conductor (especially one with high resistance), the electrical energy is converted into heat energy. This is called the heating effect of electric current (also known as Joule's heating effect). Examples include electric heaters, toasters, and electric irons.

(c) Expression for heat produced (Joule's Law of Heating):
H = I^2 x R x t
Where:
H = Heat produced (in joules)
I = Current flowing through the resistor (in amperes)
R = Resistance of the resistor (in ohms)
t = Time for which current flows (in seconds)

Derivation: Work done W = V x I x t, and by Ohm's law V = IR, so W = I^2 x R x t. This work done appears as heat energy H = I^2Rt.

Explanation:
Using P = VI and V = IR to find current and resistance.
Joule's law gives heat produced as H = I^2Rt.

Section E

Case Study Based Questions (4 marks each)

Q.37 [4 marks]

Almost all metals combine with oxygen to form metal oxides. Metal oxides are generally basic in nature. But some metal oxides show both basic as well as acidic behaviour. Different metals show different reactivities towards oxygen. Some react vigorously while some do not react at all.
(a) What happens when copper is heated in air? (Give the equation of the reaction involved.)

(b) Why are some metal oxides categorized as amphoteric? Give one example.

(c) Complete the following equations:

(i) Na2O(s) + H2O(l) ->

(ii) Al2O3 + 2NaOH ->

Answer: (a) When copper is heated in air, it reacts with oxygen to form copper oxide (black):

2Cu + O2 --heat--> 2CuO

(Copper combines with oxygen to form black copper oxide)

(b) Some metal oxides are categorized as amphoteric because they react with both acids and bases to form salt and water. They show both acidic and basic behaviour.

Example: Aluminium oxide (Al2O3), Zinc oxide (ZnO)

Al2O3 + 6HCl -> 2AlCl3 + 3H2O (reacts with acid)

Al2O3 + 2NaOH -> 2NaAlO2 + H2O (reacts with base)

(c) Completed equations:

(i) Na2O(s) + H2O(l) -> 2NaOH(aq) (Sodium hydroxide)

(ii) Al2O3 + 2NaOH -> 2NaAlO2 + H2O (Sodium aluminate and water)

Explanation:

Copper forms black CuO when heated.

Amphoteric oxides react with both acids and bases.

Na2O forms NaOH with water.

OR

Q.37 [4 marks]

(OR)

(c) On burning Sulphur in oxygen a colourless gas is produced.

(i) Write chemical equation for the reaction.

(ii) Name the gas formed.

(iii) State the nature of the gas.

(iv) What will be the action of this on a dry litmus paper?

Answer: (i) S + O2 -> SO2 (Sulphur dioxide)

(or S(s) + O2(g) -> SO2(g))

(ii) The gas formed is Sulphur dioxide (SO2).

(iii) Sulphur dioxide is acidic in nature. It is a non-metal oxide. When dissolved in water, it forms sulphurous acid (H2SO3):

SO2 + H2O -> H2SO3

(iv) Dry litmus paper will show no change. This is because SO2 is acidic only in the presence of water/moisture. Dry litmus paper has no moisture, so the acidic nature cannot be detected. However, if moist litmus paper is used, blue litmus would turn red.

Explanation:

Burning sulphur produces SO2 (acidic gas).

It has no effect on dry litmus paper as acids need water to show their properties.

Q.38(a) [4 marks]

In order to trace the inheritance of traits Mendel crossed pea plants having one contrasting character or a pair of contrasting characters. When he crossed pea plants having round and yellow seeds with pea plants having wrinkled and green seeds, he observed that no plants with wrinkled and green seeds were obtained in the F1 generation. When the F1 generation pea plants were cross-bred by self-pollination, the F2 generation had seeds with different combinations of shape and colour also.

(a) Write any two pairs of contrasting characteristics of pea plant used by Mendel other than those mentioned above.

(b) Differentiate between dominant and recessive traits.

(c) State the ratio of the combinations observed in the seeds of F2 generation (in the above case). What do you interpret from this result?

Answer: (a) Two pairs of contrasting characteristics:

1. Tall plants vs Dwarf plants (stem height)

2. Purple flowers vs White flowers (flower colour)

(Other valid pairs: Axial vs Terminal flower position, Green vs Yellow pod colour, Inflated vs Constricted pod shape)

(b) Dominant trait: The trait that expresses itself in the F1 generation (heterozygous condition) is called the dominant trait. Example: Round shape, Yellow colour.

Recessive trait: The trait that is suppressed in the F1 generation and appears only in the homozygous condition is called the recessive trait. Example: Wrinkled shape, Green colour.

(c) The ratio of combinations in F2 generation is 9:3:3:1

- 9 Round Yellow
- 3 Round Green
- 3 Wrinkled Yellow
- 1 Wrinkled Green

Interpretation: This shows that traits are inherited independently of each other (Law of Independent Assortment). The genes for seed shape and seed colour are on different chromosomes and segregate independently during gamete formation, producing new combinations in the offspring.

Explanation:

Mendel's dihybrid cross gives 9:3:3:1 ratio in F2, demonstrating the Law of Independent Assortment.

OR

Q.38(a) [4 marks]

(OR) (c) Given below is a cross between a pure violet flowered pea plant (V) and a pure white flowered pea plant (v). Diagrammatically explain what type of progeny is obtained in F1 generation and F2 generation:

Pure violet flowered plant x Pure white flowered plant

(VV) (vv)

Answer: F1 Generation:

Parents: VV (violet) x vv (white)

Gametes: V, V from one parent; v, v from other parent

F1 offspring: All Vv (violet flowered) - 100% violet

(Violet is dominant over white)

F2 Generation (F1 x F1):

Parents: Vv x Vv

Gametes: V, v from each parent

Punnett Square:

	V	v
V	VV	Vv
v	Vv	vv

F2 offspring:

- VV (violet): 1
- Vv (violet): 2
- vv (white): 1

Phenotypic ratio: 3 Violet : 1 White

Genotypic ratio: 1 VV : 2 Vv : 1 vv

Explanation:

Monohybrid cross: F1 is all heterozygous dominant.

F2 gives 3:1 phenotypic ratio (Law of Dominance and Segregation).

Q.39(a) [4 marks]

Hold a concave mirror in your hand and direct its reflecting surface towards the sun. Direct the light reflected by the mirror on to a white card-board held close to the mirror. Move the card-board back and forth gradually until you find a bright, sharp spot of light on the board. This spot of light is the image of the sun on the sheet of paper; which is also termed as 'Principal Focus' of the concave mirror.

(a) List two applications of concave mirror.

(b) If the distance between the mirror and the principal focus is 15 cm, find the radius of curvature of the mirror.

(c) Draw a ray diagram to show the type of image formed when an object is placed between pole and focus of a concave mirror.

Answer: (a) Two applications of concave mirror:

1. Used as shaving mirrors / makeup mirrors (to see a magnified image of the face).

2. Used by dentists to see a magnified image of teeth.

(Other valid: Used in headlights of vehicles, solar furnaces, reflecting telescopes)

(b) Focal length f = 15 cm

Radius of curvature R = 2f = 2 x 15 = 30 cm

(c) When an object is placed between the pole (P) and focus (F) of a concave mirror:

- A ray parallel to the principal axis reflects through the focus.
- A ray directed towards the centre of curvature reflects back along the same path.
- The reflected rays diverge and do not meet in front of the mirror.
- They appear to meet behind the mirror when extended backwards.

- Image formed is: Virtual, erect, and enlarged (magnified)
- Position: Behind the mirror

Explanation:

R = 2f gives radius of curvature.

Object between P and F of concave mirror forms virtual, erect, enlarged image behind the mirror.

OR

Q.39(a) [4 marks]

(OR) (c) An object 10 cm in size is placed at 100 cm in front of a concave mirror. If its image is formed at the same point where the object is located, find:

(i) focal length of the mirror, and

(ii) magnification of the image formed with sign as per Cartesian sign convention.

Answer: (i) If the image is formed at the same point as the object, the object must be placed at the centre of curvature (C).

So, object distance u = -100 cm (negative as per sign convention)

Image distance v = -100 cm (image at same point, in front of mirror)

Radius of curvature R = 100 cm

Focal length f = R/2 = 100/2 = 50 cm

With sign convention: f = -50 cm

Verification using mirror formula: 1/v + 1/u = 1/f

1/(-100) + 1/(-100) = 1/f

-2/100 = 1/f

f = -50 cm

(ii) Magnification m = -v/u = -(-100)/(-100) = -1

The magnification is -1, which means:

- The image is the same size as the object (|m| = 1)
- The negative sign indicates the image is real and inverted.

Explanation:

When image forms at the object location in a concave mirror, the object is at C.

f = R/2 = 50 cm.

Magnification = -1 (real, inverted, same size).