CBSE 2020 Science — Set 2 — Answer Key

English Medium

Time Allowed: 3 Hours | Maximum Marks: 80

General Instructions:

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

Section A

Multiple Choice Questions (1 mark each)

Q.1 [1 mark]

Covalent compounds have low melting and boiling point. Why?

Answer: Covalent compounds have low melting and boiling points because the intermolecular forces of attraction between the molecules of covalent compounds are weak. These weak van der Waals forces require less energy to break, resulting in low melting and boiling points.

Explanation:

Covalent compounds are formed by sharing of electrons between atoms.

The molecules are held together by weak intermolecular forces (van der Waals forces), unlike ionic compounds which have strong electrostatic forces of attraction between ions.

Hence, less energy is needed to overcome these forces, resulting in low melting and boiling points.

Q.2 [1 mark]

How many metals are present in second period of periodic table?

Answer: There are 2 metals in the second period of the periodic table — Lithium (Li) and Beryllium (Be).

Explanation:

The second period of the periodic table contains 8 elements: Li, Be, B, C, N, O, F, Ne.

Among these, Lithium (Li) and Beryllium (Be) are metals.

Boron is a metalloid, and the rest are non-metals.

So there are 2 metals in the second period.

Q.3(a) [1 mark]

Read the passage on geothermal energy and answer:

Geothermal energy is the energy produced by the heat of molten rocks formed in the deeper hot regions of the earth's crust. This energy is

harnessed to generate electricity. When water is made to flow deep underground in the rocks it returns as steam (or hot water, which is later converted to steam) to drive a turbine on an electric power generator.

In India, exploration and study of geothermal fields started in 1970. The Geological Survey of India has identified 350 geothermal energy locations in the country. The most promising of these is in Puga valley of Ladakh. The estimated geothermal potential for energy in India is about 10000 MW. There are seven geothermal provinces in India namely the Himalayas, Sohna, West coast, Cambay, Son-Narmada-Tapi, Godavari and Mahanadi. Most power stations in India produce Alternating Current (A.C.).

(a) What are geothermal energy hot-spots?

Answer: Geothermal energy hot-spots are areas on the earth's surface where hot molten rocks (magma) are present at relatively shallow depths. At these spots, underground water comes in contact with the hot rocks and turns into steam, which can be harnessed for generating electricity.

Explanation:

Hot-spots are regions where the molten rocks formed due to geological changes are pushed upward and get trapped in certain regions called hot-spots.

When underground water comes in contact with these hot-spots, it turns into steam which is used to generate electricity.

Q.3(b) [1 mark]

(Based on geothermal energy passage) (b) Name two countries, other than India, where power plants based on geothermal energy are operational.

Answer: Two countries other than India where geothermal energy power plants are operational are New Zealand and the United States of America.

Explanation:

Geothermal power plants are operational in several countries.

New Zealand and the USA are two prominent examples.

Other countries include Iceland, Philippines, and Indonesia.

Q.3(c) [1 mark]

(Based on geothermal energy passage) (c) Name the phenomenon that explains the working of an electric generator.

Answer: The phenomenon that explains the working of an electric generator is electromagnetic induction.

Explanation:

Electromagnetic induction is the phenomenon of generating an induced electromotive force (emf) and hence an induced current in a coil when the magnetic flux through it changes.

In a generator, a coil is rotated in a magnetic field, which changes the magnetic flux and induces an electric current.

Q.3(d) [1 mark]

(Based on geothermal energy passage) (d) State an important advantage of using AC over DC.

Answer: An important advantage of AC over DC is that AC can be easily transmitted over long distances without much loss of energy by stepping up the voltage using transformers. DC cannot be stepped up or down using transformers.

Explanation:

AC can be transmitted over long distances at high voltages (stepped up by transformers) with minimal energy loss.

At the receiving end, it can be stepped down to lower voltages for safe use.

Transformers do not work with DC, making long-distance DC transmission inefficient due to significant energy loss.

Q.4(a) [1 mark]

Read the passage on thyroid gland and answer:

Thyroid gland is a bilobed structure situated in our neck region. It secretes a hormone called thyroxine. Iodine is necessary for the thyroid gland to make

thyroxine. Thyroxine regulates carbohydrate, protein and fat metabolism in the body. It promotes growth of body tissues also. When there is an excess of thyroxine in the body, a person suffers from hyperthyroidism and if this gland is underactive it results in hypothyroidism. Hyperthyroidism is diagnosed by blood tests that measure the levels of thyroxine and Thyroid Stimulating Hormone (TSH). Hypothyroidism is caused due to the deficiency of iodine in our diet resulting in a disease called goitre. Iodised salt can be included in our diet to control it.

(a) Where is thyroid gland situated in our body?

Answer: The thyroid gland is situated in the neck region of our body.

Explanation:

The thyroid gland is a bilobed (butterfly-shaped) structure located in the neck region, just below the larynx (voice box) and in front of the trachea (windpipe).

Q.4(b) [1 mark]

(Based on thyroid gland passage) (b) State the function of thyroxine in human body.

Answer: Thyroxine regulates carbohydrate, protein and fat metabolism in the body. It also promotes the growth of body tissues.

Explanation:

Thyroxine is the hormone secreted by the thyroid gland.
Its main functions are: (1) Regulation of the metabolism of carbohydrates, proteins and fats, (2) Promotion of growth of body tissues, and (3) Regulation of the basal metabolic rate (BMR) of the body.

Q.4(c) [1 mark]

(Based on thyroid gland passage) (c) What is hyperthyroidism?

Answer: Hyperthyroidism is a condition in which there is an excess of thyroxine hormone in the body due to the overactivity of the thyroid gland.

Explanation:

When the thyroid gland becomes overactive and produces excess thyroxine, it leads to hyperthyroidism.

This can cause symptoms like weight loss, rapid heartbeat, nervousness, and increased sweating.

It is diagnosed by blood tests measuring thyroxine and TSH levels.

Q.4(d) [1 mark]

(Based on thyroid gland passage) (d) How can we control hypothyroidism?

Answer: Hypothyroidism can be controlled by including iodised salt in our diet, as iodine is necessary for the thyroid gland to produce thyroxine.

Explanation:

Hypothyroidism is caused by the deficiency of iodine in the diet, which leads to underactive thyroid gland and can result in goitre (swelling of the thyroid gland in the neck).

By using iodised salt in our daily diet, we can ensure adequate iodine intake and prevent/control hypothyroidism.

Q.5 [1 mark]

Consider the following reasons for the reddish appearance of the sun at the sunrise or the sunset:

A. Light from the sun near the horizon passes through thinner layers of air.

B. Light from the sun covers larger distance of the earth's atmosphere before reaching our eyes.

C. Near the horizon, most of the blue light and shorter wavelengths are scattered away by the particles.

D. Light from the sun near the horizon passes through thicker layers of air.

The correct reasons are:

(a) A and C only

(b) B, C and D <<

(c) A and B only

(d) C and D only

Explanation:

At sunrise/sunset the light passes through thicker layers of air (D) and so covers a larger distance in the atmosphere (B);

most blue and shorter wavelengths are scattered away (C).

A is wrong (thinner layers).

So B, C and D are correct: option (b).

OR

Q.5 [1 mark]

A person suffering from cataract has:

(a) elongated eyeball

(b) excessive curvature of eye lens

(c) weakened ciliary muscles

(d) opaque eye lens

(a) elongated eyeball

(b) excessive curvature of eye lens

(c) weakened ciliary muscles

(d) opaque eye lens <<

Explanation:

Cataract is an eye disease in which the crystalline lens of the eye becomes opaque (cloudy/milky white).

This opacity prevents light from passing through the lens properly, leading to partial or complete loss of vision.

Cataract is common in old age and can be corrected by surgery in which the opaque lens is replaced with an artificial intraocular lens.

Q.6 [1 mark]

The maximum resistance which can be made using four resistors each of 2 Ω is:

(a) 2 Ω

(b) 4 Ω

(c) 8 Ω <<

(d) 16 Ω

Explanation:

The maximum resistance is obtained when all resistors are connected in series.

For series combination: R_total = R_1 + R_2 + R_3 + R_4 = 2 + 2 + 2 + 2 = 8 Ω.

So the maximum resistance possible is 8 Ω.

Q.7 [1 mark]

A student plots V-I graphs for three samples of nichrome wire with resistances R_1, R_2 and R_3. Choose from the following the statement that holds true for this graph.

(In the graph, R_3 has the steepest slope, R_1 is in the middle, and R_2 has the least slope, with I on the y-axis and V on the x-axis)

(a) $R_1 = R_2 = R_3$

(b) $R_1 > R_2 > R_3$

(c) $R_3 > R_2 > R_1$

(d) $R_2 > R_1 > R_3$ <<

Explanation:

In a V-I graph (V on x-axis, I on y-axis), the slope = I/V = 1/R.

A steeper line means a larger slope, i.e., smaller resistance.

From the graph, R_3 has the steepest slope (smallest resistance) and R_2 has the least slope (largest resistance).

Therefore $R_2 > R_1 > R_3$.

Q.8 [1 mark]

Which of the following are water intensive crops?

(a) Wheat and rice

(b) Wheat and sugarcane

(c) Sugarcane and rice <<

(d) Wheat and gram

Explanation:

Sugarcane and rice are water intensive crops.

Rice requires standing water in paddy fields (puddled fields) and sugarcane also requires large amounts of water for irrigation.

Wheat and gram are comparatively less water intensive crops.

OR

Q.8 [1 mark]

The most poisonous product formed by incomplete combustion of fossil fuels is:

(a) Carbon dioxide
(b) Nitrogen dioxide
(c) Carbon monoxide <<
(d) Sulphur dioxide

Explanation:

Carbon monoxide (CO) is the most poisonous product formed by incomplete combustion of fossil fuels.

It is a colourless, odourless and highly toxic gas.

It binds with haemoglobin in the blood more readily than oxygen, reducing the oxygen-carrying capacity of blood, which can be fatal.

Q.9 [1 mark]

Bandharas and Tals are age old water harvesting concepts / structures found in:

(a) Bihar
(b) Maharashtra <<
(c) Tamil Nadu
(d) Rajasthan

Explanation:

Bandharas and Tals are traditional water harvesting structures found in Maharashtra.

Different states have their own traditional water harvesting systems: Rajasthan has Khadins and Nadis, Karnataka has Kattas, and Kerala has Surangams.

Q.10 [1 mark]

Identify 'x', 'y' and 'z' in the following reaction:

$2\ KClO_3(x) \xrightarrow{(y)} 2\ KCl(x) + O_2(z)$

(a) x = gas; y = reaction condition; z = gas

(b) x = solid; y = liquid; z = gas

(c) x = number of moles of $KClO_3$; y = reaction condition; z = no. of molecules of oxygen

(d) x = physical state of $KClO_3$ and KCl; y = reaction condition; z = physical state of O_2 <<

Explanation:

In a balanced chemical equation: (x) after $KClO_3$ and KCl represents the physical state of the compounds (both are solids), (y) above the arrow represents the reaction condition (such as heating/catalyst), and (z) after O_2 represents the physical state of oxygen (gas).

So x = physical state of $KClO_3$ and KCl, y = reaction condition, z = physical state of O_2.

Q.11 [1 mark]

A visually challenged student, has to perform a lab test to detect the presence of acid in a given solution. The acid-base indicator preferred by him will be:

(a) Blue litmus

(b) Clove oil <<

(c) Red cabbage extract

(d) Hibiscus extract

Explanation:

A visually challenged student cannot see colour changes, so they need an olfactory (smell-based) indicator.

Clove oil is an olfactory indicator — its smell changes in acidic and basic solutions.

Blue litmus, red cabbage extract, and hibiscus extract are all visual indicators that require seeing colour changes.

Q.12 [1 mark]

On the basis of electronic configuration of $^{9}_{5}X$, the group number and period of the element 'X' is:

(a) Group 15 period 2

(b) Group 13 period 2 <<

(c) Group 9 period 5

(d) Group 13 period 5

Explanation:

The element X has atomic number 5 (Boron).

Electronic configuration: 2, 3.

Number of shells = 2, so Period = 2.

Boron is a p-block element with 3 valence electrons.

Group number = 10 + 3 = 13.

Therefore, X belongs to Group 13, Period 2.

OR

Q.12 [1 mark]

An element 'X' with atomic number 11 forms a compound with element 'Y' with atomic number 8. The formula of the compound formed is:

(a) XY

(b) X_2Y <<

(c) XY_2

(d) X_2Y_3

Explanation:

Element X with atomic number 11 is Sodium (Na) with electronic configuration 2, 8, 1.

It has valency 1 (loses 1 electron).

Element Y with atomic number 8 is Oxygen (O) with electronic configuration 2, 6.

It has valency 2 (gains 2 electrons).

To form a compound, 2 atoms of X (valency 1) combine with 1 atom of Y (valency 2) to balance the charges.

Therefore, the formula is X_2Y (like Na_2O).

Q.13 [1 mark]

For questions 13 and 14, two statements are given — one labelled Assertion (A) and the other labelled as Reason (R). Select the correct answer from the codes (a), (b), (c) and (d):

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

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

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

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

Assertion (A): Ethanoic acid is also known as glacial acetic acid.

Reason (R): The melting point of pure ethanoic acid is 290 K and hence it often freezes during winters in cold climates.

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

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

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

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

Explanation:

Both the assertion and reason are true, and the reason correctly explains the assertion.

Ethanoic acid (CH_3COOH) is called glacial acetic acid because pure (100%) ethanoic acid has a melting point of 290 K (16.6°C), which means it freezes into ice-like crystals during cold winters.

The word 'glacial' refers to this ice-like (glacier-like) freezing behavior.

Q.14 [1 mark]

Assertion (A): The metals and alloys are good conductors of electricity.

Reason (R): Bronze is an alloy of copper and tin and it is not a good conductor of electricity.

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

Explanation:

Assertion (A) is true — metals and alloys are generally good conductors of electricity due to the presence of free electrons.

Reason (R) is false — Bronze (alloy of copper and tin) IS a conductor of electricity, though its conductivity is lower than pure metals.

Alloys generally have higher resistivity than pure metals but are still conductors.

Since A is true and R is false, the answer is (c).

Q.15 [1 mark]

A compound 'A' is used in the manufacture of cement. When dissolved in water, it evolves a large amount of heat and forms compound 'B'.

(i) Identify A and B.

(ii) Write the chemical equation for the reaction of A with water.

(iii) List two types of reactions in which this reaction may be classified.

Answer: A is Calcium oxide (CaO) / Quicklime and B is Calcium hydroxide $Ca(OH)_2$ / Slaked lime.

Chemical equation: $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq) + Heat$

This reaction can be classified as: (1) Combination reaction (two substances combine to form one product), (2) Exothermic reaction (heat is released).

Explanation:

Calcium oxide (quicklime/CaO) is used in manufacturing cement.

When CaO reacts with water, it produces calcium hydroxide (slaked lime) and releases a large amount of heat.

$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq) + Heat.$

This is a combination reaction because two reactants combine to form a single product, and it is an exothermic reaction because heat energy is released.

Q.16 [1 mark]

Give reasons for the following:

(i) Only one half of a water molecule is shown in the formula of Plaster of Paris.

(ii) Sodium hydrogen carbonate is used as an antacid.

(iii) On strong heating, blue coloured copper sulphate crystals turn white.

Answer: (i) Plaster of Paris has the formula $CaSO_4.½H_2O$. The $½H_2O$ means that one molecule of water is shared between two formula units of $CaSO_4$, so each unit is associated with only half a water molecule.

(ii) Sodium hydrogen carbonate ($NaHCO_3$) is used as an antacid because it is a mild base that neutralizes the excess hydrochloric acid (HCl) present in the stomach, thereby relieving acidity and indigestion.

(iii) Blue copper sulphate crystals ($CuSO_4.5H_2O$) contain water of crystallisation (5 molecules). On strong heating, this water of crystallisation is removed, and the blue crystals turn into white anhydrous copper sulphate ($CuSO_4$).

Explanation:

(i) The formula of Plaster of Paris is $CaSO_4.½H_2O$ (Calcium sulphate hemihydrate). The ½ indicates that two formula units of $CaSO_4$ share one molecule of water.

(ii) $NaHCO_3$ being basic neutralizes excess stomach acid: $NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$.

(iii) $CuSO_4.5H_2O$ (blue) loses its water of crystallisation on heating to form $CuSO_4$ (white): $CuSO_4.5H_2O \rightarrow (heat) \rightarrow CuSO_4 + 5H_2O$.

OR

Q.16 [1 mark]

OR:

(i) Draw a labelled diagram to show the preparation of hydrogen chloride gas in laboratory.

(ii) Test the gas evolved first with dry and then with wet litmus paper. In which of the two cases, does the litmus paper show change in colour?

(iii) State the reason of exhibiting acidic character by dry HCl gas / HCl

solution.

Answer: (i) Diagram: A round-bottom flask containing NaCl and concentrated H_2SO_4, fitted with a delivery tube. The flask is heated. The gas is collected by upward displacement of air in a gas jar. Label: Flask, NaCl + conc. H_2SO_4, delivery tube, gas jar.

Reaction: $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

(ii) Dry litmus paper shows no change in colour. Wet litmus paper turns red (if blue litmus is used). Only wet litmus paper shows colour change.

(iii) Dry HCl gas does not show acidic character because it does not produce H^+ ions in the absence of water. HCl solution shows acidic character because HCl dissociates in water to produce H^+ (H_3O^+) ions, which are responsible for acidic behaviour. Acids produce H^+ ions only in aqueous solution.

Explanation:

HCl gas is prepared by heating NaCl with concentrated H_2SO_4.

Dry HCl gas does not change litmus colour because acids need water to dissociate and produce H^+ ions.

When HCl dissolves in moisture on wet litmus paper, it produces H^+ ions: $HCl \rightarrow H^+ + Cl^-$, turning blue litmus red.

This shows that acids exhibit acidic character only in aqueous solution because H^+ ions are generated only in the presence of water.

Q.17 [1 mark]

From the elements $^{39}_{19}A$, $^{28}_{14}B$, $^{16}_{8}C$ and $^{40}_{18}D$ identify:

(a) the most electro positive element.

(b) a noble gas.

(c) a metalloid.

(d) an element which will gain 2 electrons to attain nearest noble gas configuration.

(e) formula of compound formed between A and C.

(f) elements belonging to same period.

Answer: (a) A (Potassium, Z=19) is the most electropositive element as it is an

alkali metal with the lowest ionisation energy among the given elements.

(b) D (Argon, Z=18) is a noble gas.

(c) B (Silicon, Z=14) is a metalloid.

(d) C (Oxygen, Z=8, config 2,6) will gain 2 electrons to attain the nearest noble gas (Neon) configuration.

(e) A has valency 1 (K) and C has valency 2 (O). Formula = A_2C (like K_2O).

(f) B (Si, Z=14, period 3), C (O, Z=8, period 2), and D (Ar, Z=18, period 3). Elements B and D belong to the same period (Period 3).

Explanation:

A = Potassium (K): Z=19, config 2,8,8,1 — Period 4, Group 1, alkali metal (most electropositive).

B = Silicon (Si): Z=14, config 2,8,4 — Period 3, Group 14, metalloid.

C = Oxygen (O): Z=8, config 2,6 — Period 2, Group 16, non-metal (needs 2 electrons for Ne configuration).

D = Argon (Ar): Z=18, config 2,8,8 — Period 3, Group 18, noble gas.

B and D are in the same period (Period 3).

Compound of A and C: K_2O (A_2C).

Q.18 [1 mark]

(a) Construct a terrestrial food chain comprising four trophic levels.

(b) What will happen if we kill all the organisms in one trophic level?

(c) Calculate the amount of energy available to the organisms at the fourth trophic level if the energy available to the organisms at the second trophic level is 2000 J.

Answer: (a) A terrestrial food chain with four trophic levels: Grass → Grasshopper → Frog → Snake (or: Grass → Deer → Lion → Vulture).

(b) If all organisms in one trophic level are killed, the organisms at the next higher trophic level will die due to starvation (no food source), and the organisms at the lower trophic level will increase in population uncontrollably due to lack of predators, leading to an imbalance in the ecosystem.

(c) By the 10% law, only 10% of energy is transferred from one trophic level to the

next. Energy at 2nd trophic level = 2000 J. Energy at 3rd trophic level = 10% of 2000 = 200 J. Energy at 4th trophic level = 10% of 200 = 20 J.

Explanation:

A food chain shows the flow of energy from one organism to another.

According to the 10% law (Lindeman's rule), only 10% of energy is transferred from one trophic level to the next.

So from 2000 J at T2: T3 = 200 J, T4 = 20 J.

Killing organisms at one level disrupts the entire food chain and ecosystem balance.

OR

Q.18 [1 mark]

OR:

(a) Complete the following table:

| | Oxygen | Ozone |

| Formula | (i) _____ | (ii) _____ |

| Benefits to biotic component | (iii) _____ | (iv) _____ |

(b) How is ozone formed at the higher levels of atmosphere?

Answer: (a) (i) O_2 (ii) O_3 (iii) Oxygen is essential for respiration in all living organisms. It is also needed for combustion and decomposition. (iv) Ozone forms a protective layer (ozone layer) in the stratosphere that absorbs harmful ultraviolet (UV) radiation from the sun, protecting living organisms from its damaging effects such as skin cancer and cataracts.

(b) Ozone is formed at higher levels of the atmosphere by the action of UV radiation on oxygen molecules. UV radiation splits O_2 molecules into free oxygen atoms (O), which then combine with other O_2 molecules to form ozone (O_3): $O_2 \rightarrow (UV) \rightarrow O + O$, then $O + O_2 \rightarrow O_3$.

Explanation:

Oxygen (O_2) is essential for aerobic respiration and combustion.

Ozone (O_3) forms a protective shield in the stratosphere against harmful UV rays.

Ozone formation: UV light breaks O_2 into atomic oxygen, which combines with another O_2 molecule to form O_3.

This is a continuous process in the stratosphere.

Q.19 [1 mark]

Complete the following flow chart as per the given instructions:

Gastric Glands Present in the wall of Stomach → Secretions → (a), (b), (c)

Each secretion has a Function: (d), (e), (f) respectively.

Identify the three secretions (a, b, c) and their functions (d, e, f).

Answer: a = Hydrochloric acid (HCl), b = Pepsin (enzyme), c = Mucus.

d = Function of HCl: Creates an acidic medium (pH ~2) in the stomach which is necessary for the activation of the enzyme pepsin. It also kills bacteria that enter with food.

e = Function of Pepsin: It is a protein-digesting enzyme that breaks down proteins into simpler peptides in the acidic medium of the stomach.

f = Function of Mucus: It protects the inner lining (mucous membrane) of the stomach from the corrosive action of hydrochloric acid and prevents the stomach from digesting itself.

Explanation:

Gastric glands in the stomach wall secrete three main substances: (1) HCl — makes the medium acidic for pepsin to work and kills germs, (2) Pepsin — a protease enzyme that digests proteins, (3) Mucus — protects the stomach lining from acid damage.

These secretions work together for effective digestion of food in the stomach.

Q.20 [1 mark]

Explain giving an example how the following provide evidences in favour of evolution in organisms.

(i) Homologous organs

(ii) Fossils

Answer: (i) Homologous organs: These are organs that have the same basic structural plan and origin but perform different functions in different organisms. For

example, the forelimbs of a human (for grasping), a whale (flippers for swimming), a bat (wings for flying), and a horse (legs for running) all have the same basic bone structure (humerus, radius, ulna, carpals, metacarpals, phalanges) but are modified for different functions. This similarity in structure suggests that these organisms have evolved from a common ancestor, providing evidence for evolution.

(ii) Fossils: Fossils are preserved remains or impressions of organisms that lived in the past. They provide direct evidence of evolution by showing how organisms have changed over time. For example, fossils of Archaeopteryx show features of both reptiles (teeth, clawed fingers, bony tail) and birds (feathers, wings), suggesting that birds evolved from reptiles. The sequence of fossils in different rock layers (strata) shows a gradual change from simpler to more complex forms of life.

Explanation:

Homologous organs show divergent evolution from a common ancestor (same structure, different functions).

Fossils provide a historical record of life forms and show transitional forms between groups.

Both are strong evidences supporting the theory of evolution proposed by Darwin.

Section B

Very Short Answer Questions (2 marks each)

Q.21 [2 marks]

What are chromosomes? Explain how in sexually reproducing organisms the number of chromosomes in the progeny is maintained.

Answer: Chromosomes are thread-like structures present in the nucleus of a cell, made up of DNA and protein (histone). They carry genes which are the units of heredity and control the characteristics of an organism.

In sexually reproducing organisms, the number of chromosomes is maintained in

the progeny through the process of meiosis and fertilization:

1. During gamete formation (gametogenesis), meiosis occurs in the reproductive cells, reducing the chromosome number to half (from diploid 2n to haploid n). For example, in humans, body cells have 46 chromosomes (2n), and gametes (sperm and egg) have 23 chromosomes (n).

2. During fertilization, the male gamete (n) fuses with the female gamete (n) to form a zygote (2n). This restores the original diploid number of chromosomes.

3. Thus, 23 (from sperm) + 23 (from egg) = 46 chromosomes in the zygote, maintaining the chromosome number across generations.

Explanation:

Chromosomes are DNA + protein structures carrying genetic information.

Meiosis halves the chromosome number in gametes, and fertilization restores it.

This ensures the species-specific chromosome number is maintained generation after generation.

Q.22 [2 marks]

What happens after refraction, when:

(i) a ray of light parallel to the principal axis passes through a concave lens?

(ii) a ray of light falls on a convex lens while passing through its principal focus?

(iii) a ray of light passes through the optical centre of a convex lens?

Answer: (i) A ray of light parallel to the principal axis, after refraction through a concave lens, appears to diverge from the principal focus on the same side as the incident ray. The refracted ray diverges outward.

(ii) A ray of light passing through the principal focus of a convex lens, after refraction, emerges parallel to the principal axis on the other side of the lens.

(iii) A ray of light passing through the optical centre of a convex lens passes through without any deviation, i.e., it continues in a straight line.

Explanation:

(i) Concave lens diverges light.

A parallel ray appears to come from focus F on the same side.

(ii) This is the reverse of the parallel ray rule for convex lens — a ray through focus emerges parallel to principal axis.

(iii) Any ray through the optical centre passes undeviated because the lens surfaces are locally parallel at the centre.

Q.23 [2 marks]

Two coils of insulated copper wire are wound over a non-conducting cylinder as shown. Coil 1 has comparative large number of turns. State your observations, when:

(i) Key K is closed.

(ii) Key K is opened.

Give reason for each of your observations.

Answer: (i) When key K is closed: The galvanometer shows a momentary deflection in one direction. This is because when the current starts flowing in Coil 1, a changing magnetic field is created which causes a change in magnetic flux linked with Coil 2. By electromagnetic induction, an induced EMF and hence an induced current is produced in Coil 2, causing the galvanometer to deflect.

(ii) When key K is opened: The galvanometer shows a momentary deflection in the opposite direction. This is because when the current in Coil 1 stops, the magnetic field collapses, causing a change in magnetic flux in Coil 2 in the opposite sense. This induces a current in the opposite direction in Coil 2.

In both cases, the deflection is momentary because the induced current flows only when there is a change in magnetic flux. Once the current in Coil 1 becomes steady (or zero), the magnetic flux is constant and no current is induced.

Explanation:

This demonstrates electromagnetic induction (Faraday's law).

A changing current in one coil creates a changing magnetic flux that induces an EMF in the nearby coil.

The direction of induced current reverses when the change in flux reverses (closing vs opening the key).

The deflection is temporary because induction requires a changing flux.

Q.24 [2 marks]

(a) List two causes of hypermetropia.

(b) Draw ray diagrams showing (i) a hypermetropic eye and (ii) its correction using suitable optical device.

Answer: (a) Two causes of hypermetropia (farsightedness):

1. The focal length of the eye lens becomes too long (the eye lens is too thin/flat and cannot curve enough).

2. The eyeball becomes too short (from front to back), so the retina is too close to the lens.

(b) Ray diagrams:

(i) Hypermetropic eye: Parallel rays from a nearby object converge at a point behind the retina instead of on the retina. The image is formed behind the retina.

(ii) Correction: A convex lens (converging lens) of suitable focal length is placed in front of the eye. The convex lens converges the light rays before they enter the eye, so that the eye lens can now focus them on the retina.

Explanation:

Hypermetropia (long-sightedness) is caused by decreased converging power of the eye lens or shortening of the eyeball.

The near point shifts farther away.

A convex lens of appropriate power is used to correct it by providing additional converging power, shifting the image back onto the retina.

OR

Q.24 [2 marks]

OR:

(a) State the relation between colour of scattered light and size of the

scattering particle.

(b) The apparent position of an object, when seen through the hot air, fluctuations or wavers. State the basic cause of this observation.

(c) Complete the path of white light when it passes through two identical prisms placed as shown (Prism 2 inverted on top of Prism 1, with white light entering Prism 1).

Answer: (a) The colour of scattered light depends on the size of the scattering particle. Very fine particles (smaller than the wavelength of light) scatter shorter wavelengths (blue) more than longer wavelengths (red) — this is Rayleigh scattering. Larger particles scatter all wavelengths equally, producing white scattered light.

(b) Hot air above a surface is optically rarer (less dense) than the cooler air above it. The refractive index of air changes continuously due to convection currents. As a result, the light rays from the object undergo continuous refraction through layers of air at different temperatures, causing the apparent position of the object to fluctuate/waver. This is similar to the twinkling of stars.

(c) When white light enters Prism 1, it disperses into its component colours (VIBGYOR spectrum). When this dispersed light enters the inverted Prism 2 (placed symmetrically), the second prism recombines all the colours back into white light. The emergent light from Prism 2 is white light. This demonstrates that white light is composed of seven colours and the dispersion by one prism can be reversed by another identical prism placed in inverted position.

Explanation:

Rayleigh scattering is inversely proportional to the fourth power of wavelength.

Hot air causes refractive index fluctuations leading to wavering images.

Two prisms in inverted arrangement: first disperses, second recombines — proving white light is a mixture of colours (Newton's experiment).

Q.25 [2 marks]

(a) How is the method of extraction of metals high up in the reactivity series

different from that for metals in the middle ? Why cannot the same process be applied for them ? Name and explain the process of extraction of sodium.
(b) Draw a labelled diagram of electrolytic refining of copper.

Answer: (a) Metals high up in the reactivity series (Na, K, Ca, Al) are extracted by electrolytic reduction of their molten salts/ores, whereas metals in the middle (Fe, Zn, Pb) are extracted by reducing their oxides with carbon (coke). The same process cannot be applied because these highly reactive metals have more affinity for oxygen than carbon, so carbon cannot reduce their oxides.

Extraction of sodium: electrolysis of molten sodium chloride. At the cathode: $Na^+ + e^- \rightarrow Na$ (sodium deposited). At the anode: $2Cl^- \rightarrow Cl_2 + 2e^-$ (chlorine liberated).

(b) Electrolytic refining of copper: a thick strip of impure copper is the anode, a thin strip of pure copper is the cathode, and acidified copper sulphate solution is the electrolyte. On passing current, copper dissolves from the anode and deposits on the cathode; impurities settle below the anode as anode mud. The diagram should label: anode (impure Cu), cathode (pure Cu), $CuSO_4$ solution, battery, anode mud.

Explanation:

Highly reactive metals need electrolysis; middle-activity metals use carbon reduction. Electrolytic refining: impure metal anode, pure metal cathode, metal-salt electrolyte.

OR

Q.25 [2 marks]

OR

What happens when (Write the balanced equation involved) –
(i) Copper is heated in air ?
(ii) Aluminium oxide is reacted with hydrochloric acid ?
(iii) Potassium reacts with water ?
(iv) Cinnabar is heated in air ?

(v) Aluminium oxide reacts with sodium hydroxide ?

Answer: (i) $2Cu + O_2 \rightarrow (heat) \rightarrow 2CuO$ (black copper(II) oxide)

(ii) $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$

(iii) $2K + 2H_2O \rightarrow 2KOH + H_2$ (vigorous reaction)

(iv) $2HgS + 3O_2 \rightarrow (heat) \rightarrow 2HgO + 2SO_2$, then $2HgO \rightarrow (heat) \rightarrow 2Hg + O_2$

(v) $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

Explanation:

Cu forms CuO on heating;

Al_2O_3 is amphoteric (reacts with both acid and base);

K reacts vigorously with water;

cinnabar is roasted to HgO, which decomposes to Hg.

Q.26 [2 marks]

(a) What is a homologous series? Explain with an example.

(b) Define the following terms giving one example of each.

(i) Esterification

(ii) Addition reaction

Answer: (a) A homologous series is a group of organic compounds having the same general formula, same functional group, similar chemical properties, and successive members differing by a $-CH_2-$ unit and 14 u in molecular mass. Each successive member differs from the previous one by one carbon and two hydrogen atoms.

Example: The alkane homologous series: CH_4 (Methane), C_2H_6 (Ethane), C_3H_8 (Propane), C_4H_{10} (Butane). General formula: C_nH_{2}_n_{+2}. Each member differs by $-CH_2-$ (14 u).

(b)(i) Esterification: It is a chemical reaction in which a carboxylic acid reacts with an alcohol in the presence of an acid catalyst (usually concentrated H_2SO_4) to form an ester and water.

Example: $CH_3COOH + C_2H_5OH \rightarrow (H_2SO_4) \rightarrow CH_3COOC_2H_5 + H_2O$

(Ethanoic acid + Ethanol → Ethyl ethanoate + Water)

(b)(ii) Addition reaction: It is a reaction in which atoms or groups of atoms are added to unsaturated hydrocarbons (containing double or triple bonds) to form a single saturated product.

Example: $CH_2=CH_2 + H_2 \rightarrow$(Ni catalyst)$\rightarrow CH_3–CH_3$

(Ethene + Hydrogen → Ethane)

Explanation:

A homologous series shares functional group, general formula, and shows gradation in physical properties.

Esterification is acid + alcohol forming ester (sweet-smelling compound).

Addition reactions convert unsaturated compounds to saturated ones by adding atoms across the double/triple bond.

Section C

Short Answer Questions (3 marks each)

Q.27 [3 marks]

(a) Describe the structure and function of the basic filtering unit of kidney.

(b) List two factors on which reabsorption of water from urine depends.

Answer: (a) The basic filtering unit of the kidney is called the nephron. Structure: Each nephron consists of:

1. Bowman's capsule — a cup-shaped structure at one end that encloses a bundle of capillaries called the glomerulus.

2. Glomerulus — a network of blood capillaries formed by the afferent arteriole. Blood enters under high pressure.

3. Tubular part — consisting of the proximal convoluted tubule (PCT), loop of Henle, and distal convoluted tubule (DCT).

4. Collecting duct — where the DCT opens, collecting urine from multiple nephrons.

Function: Blood is filtered under high pressure in the glomerulus (ultrafiltration). The filtrate passes through the tubular part where useful substances like glucose, amino acids, salts, and water are selectively reabsorbed back into the blood. The remaining fluid (urine) containing urea, excess water, and waste salts passes into the collecting duct and then to the ureter.

(b) Two factors on which reabsorption of water from urine depends:

1. The amount of excess water in the body (hydration level).
2. The amount of dissolved wastes to be excreted (concentration of solutes in the filtrate).

Explanation:

The nephron is the structural and functional unit of the kidney.
It performs ultrafiltration in the glomerulus and selective reabsorption in the tubules.
Water reabsorption depends on the body's hydration status and solute concentration.

Q.28 [3 marks]

(a) List three different categories of contraception methods.
(b) Why has Government of India prohibited prenatal sex determination by law? State its benefits in the long run.
(c) Unsafe sexual act can lead to various infections. Name two bacterial and two viral infections caused due to unsafe sex.

Answer: (a) Three categories of contraception methods:

1. Barrier methods — e.g., condoms, diaphragm (physically prevent sperm from reaching the egg).
2. Chemical/Hormonal methods — e.g., oral contraceptive pills (change hormonal balance to prevent ovulation).
3. Surgical methods — e.g., vasectomy (in males) and tubectomy (in females) (permanent methods that block the passage of gametes).

(b) The Government of India has prohibited prenatal sex determination by law

(PCPNDT Act, 1994) because it was being misused for female foeticide (selective abortion of female foetuses). This practice led to a declining sex ratio (fewer females per 1000 males). In the long run, this law helps in:

- Maintaining a balanced sex ratio in the population.
- Preventing discrimination against the girl child.
- Ensuring equal rights and opportunities for females.

(c) Bacterial infections caused by unsafe sex: (1) Gonorrhoea, (2) Syphilis.
Viral infections caused by unsafe sex: (1) HIV-AIDS, (2) Genital warts (caused by HPV).

Explanation:

Contraception methods are broadly classified as barrier, chemical/hormonal, and surgical.

Prenatal sex determination is banned to prevent female foeticide and maintain sex ratio.

STIs can be bacterial (gonorrhoea, syphilis) or viral (HIV-AIDS, genital warts/herpes).

OR

Q.28 [3 marks]

OR:

(a) In the female reproductive system of human beings, state the functions of:

(i) ovary

(ii) oviduct

(b) Mention the changes which the uterus undergoes, when:

(i) it has to receive a zygote.

(ii) no fertilization takes place.

(c) State the function of placenta.

Answer: (a) Functions:

(i) Ovary: The ovary produces female gametes (eggs/ova) and secretes female sex hormones (estrogen and progesterone) that control the development of

secondary sexual characters and regulate the menstrual cycle.
(ii) Oviduct (Fallopian tube): The oviduct carries the egg from the ovary to the uterus. Fertilization (fusion of sperm and egg) takes place in the oviduct.

(b) Changes in the uterus:
(i) When it has to receive a zygote: The inner lining (endometrium) of the uterus becomes thick and richly supplied with blood vessels to nourish the growing embryo. This prepares the uterus for implantation of the zygote/embryo.
(ii) When no fertilization takes place: The thick uterine lining breaks down and is shed along with blood and mucus through the vagina. This is called menstruation, which occurs approximately every 28 days.

(c) Function of placenta: The placenta is a disc-shaped tissue embedded in the uterine wall that provides a connection between the mother and the developing foetus. It facilitates the transfer of nutrients and oxygen from the mother's blood to the foetus and removes waste products (CO_2 and metabolic wastes) from the foetus to the mother's blood. It also acts as a barrier to protect the foetus from infections.

Explanation:
Ovaries produce eggs and hormones.
Oviducts transport eggs and are the site of fertilization.
The uterus lining thickens for implantation or sheds during menstruation.
The placenta is the exchange interface between mother and foetus for nutrients, oxygen, and waste removal.

Q.29 [3 marks]

(a) Find the ratio of resistances of two copper rods X and Y of lengths 30 cm and 10 cm respectively and having radii 2 cm and 1 cm respectively.
(b) A current of 500 mA flows in a series circuit containing an electric lamp and a conductor of 10 Ω when connected to a 6 V battery. Find the resistance of the electric lamp.

Answer: (a) Resistance R = ρL/A, where L is length and A is cross-sectional area (πr^2).

For rod X: $R_X = \rho \times 30 / (\pi \times 2^2) = 30\rho / 4\pi$

For rod Y: $R_Y = \rho \times 10 / (\pi \times 1^2) = 10\rho / \pi$

$R_X / R_Y = (30\rho/4\pi) / (10\rho/\pi) = 30/(4\times10) = 30/40 = 3/4$

Ratio of resistances $R_X : R_Y = 3 : 4$

(b) Current I = 500 mA = 0.5 A, Voltage V = 6 V, Resistance of conductor = 10 Ω

Total resistance in series: $R_{total} = V/I = 6/0.5 = 12\ \Omega$

Resistance of lamp = $R_{total} - R_{conductor} = 12 - 10 = 2\ \Omega$

Explanation:

$R = \rho L/A$.

For same material (ρ same), ratio depends on L and A.

$R_X/R_Y = (L_X/A_X)/(L_Y/A_Y) = (30/4\pi)/(10/\pi) = 3/4$.

For part (b), using Ohm's law V = IR to find total R, then subtracting the known resistance gives the lamp resistance.

Q.30 [3 marks]

(a) A concave mirror of focal length 10 cm can produce a magnified real as well as virtual image of an object placed in front of it. Draw ray diagrams to justify this statement.

(b) An object is placed perpendicular to the principal axis of a convex mirror of focal length 10 cm. The distance of the object from the pole of the mirror is 10 cm. Find the position of the image formed.

Answer: (a) Magnified real image: When the object is placed between F and C (between focus and centre of curvature) of a concave mirror, a magnified, real, and inverted image is formed beyond C.

Magnified virtual image: When the object is placed between F and P (between focus and pole) of a concave mirror, a magnified, virtual, and erect image is formed behind the mirror.

(b) For a convex mirror: f = +10 cm (positive for convex mirror), u = -10 cm (object distance is always negative)

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

1/v + 1/(-10) = 1/10

1/v = 1/10 + 1/10 = 2/10 = 1/5

v = +5 cm

The image is formed 5 cm behind the mirror (virtual, erect, and diminished).

Explanation:

A concave mirror produces magnified real images when object is between C and F, and magnified virtual images when object is between F and P.

For convex mirror with f=10cm and u=-10cm: using 1/v + 1/u = 1/f gives v = +5 cm (behind mirror, virtual).

OR

Q.30 [3 marks]

OR:

(a) Define the following terms:

(i) Power of a lens

(ii) Principal focus of a concave mirror

(b) Write the relationship among the object distance (u), image distance (v) and the focal length (f) of a:

(i) Spherical lens

(ii) Spherical mirror

(c) An object is placed at a distance of 10 cm from the optical centre of a convex lens of focal length 15 cm. Draw a labelled ray diagram to show the formation of image in this case.

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

(a)(ii) Principal focus of a concave mirror: The principal focus of a concave mirror is the point on the principal axis where all light rays parallel to the principal axis

converge (meet) after reflection from the mirror.

(b)(i) Lens formula: 1/v - 1/u = 1/f

(b)(ii) Mirror formula: 1/v + 1/u = 1/f

(c) Object distance u = -10 cm, focal length f = +15 cm (convex lens)

Since the object is placed between F and O (within focal length, as 10 < 15), the image formed will be virtual, erect, and magnified, on the same side as the object.

Using lens formula: 1/v - 1/(-10) = 1/15

1/v + 1/10 = 1/15

1/v = 1/15 - 1/10 = (2-3)/30 = -1/30

v = -30 cm

The image is formed 30 cm from the lens on the same side as the object. It is virtual, erect, and magnified (magnification = v/u = -30/-10 = 3 times).

Explanation:

Power = 1/f(in metres).

Principal focus of concave mirror is where parallel rays converge.

Lens formula: 1/v - 1/u = 1/f.

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

Object within focal length of convex lens gives virtual, erect, magnified image at v = -30 cm.