# CBSE 2020 Science — Set 3 — 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]

How are covalent bonds formed?

Answer: Covalent bonds are formed by the sharing of electrons between two atoms. Each atom contributes one or more electrons to form shared pairs, allowing both atoms to achieve a stable electronic configuration (octet or duplet).

Explanation:

Covalent bonds involve mutual sharing of electron pairs between atoms (typically non-metals).

For example, in $H_2$, each hydrogen atom shares one electron to form a single covalent bond, achieving the stable duplet configuration.

Q.2 [1 mark]

Define electropositivity.

Answer: Electropositivity is the tendency of an atom to lose electrons and form positive ions (cations).

Explanation:

Electropositivity measures how easily an atom can donate its valence electrons.

Metals are generally electropositive.

Electropositivity increases down a group (as atomic size increases, outermost electrons are farther from the nucleus and easier to lose) and decreases across a period from left to right.

OR

Q.2 [1 mark]

The atomic radii of first group elements are given below:

Group-I Element — Atomic Radii (pm):

Na — 86

K — 231
Rb — 244
Cs — 282

State the reason behind the observed trend in the above elements.

Answer: The atomic radius increases as we go down the group from Na to Cs because a new shell of electrons is added at each step, increasing the distance of the outermost electrons from the nucleus, despite the increase in nuclear charge.

Explanation:

In Group I (alkali metals), as we move from Na to Cs, each successive element has one additional electron shell.
This increases the atomic size.
Although nuclear charge also increases, the shielding effect of inner electron shells outweighs it, resulting in a net increase in atomic radius down the group.

Q.3(a) [1 mark]

(Based on the passage about Tehri Dam)

The Tehri Dam is the highest dam in India and one of the highest in the World. The Tehri Dam withholds a reservoir of capacity 4.0 $km^3$ and surface area 52 $km^2$. It is used for irrigation, municipal water supply and the generation of 1000 MW of hydro electricity.

The Tehri Dam has been the object of protests. Environment activist Shri Sunder Lal Bahuguna led the 'Anti Tehri Dam Movement' from 1980s to 2014. The protest was against the displacement of town inhabitants and environmental consequences of the weak ecosystem. The relocation of more than 1,00,000 people from the area has led to protracted legal battles over resettlement rights and ultimately resulted in the delayed completion of the project.

(a) How is hydropower harnessed?

Answer: Hydropower is harnessed by collecting water from rivers behind dams at a height. When the water is allowed to fall from this height, the potential energy of the stored water is converted to kinetic energy, which rotates the turbines connected to generators to produce electricity.

Explanation:

Hydropower plants use the gravitational potential energy of water stored at a height.
The falling water drives turbines which are connected to electric generators.
The energy conversion chain is: Potential energy →
Kinetic energy →
Rotational energy of turbine →
Electrical energy.

Q.3(b) [1 mark]

(Based on Tehri Dam passage)

(b) Define 1 MW.

Answer: 1 MW (megawatt) = $10^6$ watts = 1,000,000 watts. It is a unit of power equal to one million watts.

Explanation:

MW stands for megawatt.
The prefix 'mega' means $10^6$ (one million).
So 1 MW = $10^6$ W = 1,000,000 W.
Power is the rate of doing work or the rate of energy transfer.

Q.3(c) [1 mark]

(Based on Tehri Dam passage)

(c) Mention two disadvantages of constructing Tehri Dam.

Answer: (i) Displacement of a large number of people (over 1,00,000) from the area leading to resettlement issues.

(ii) Environmental damage to the weak/fragile ecosystem of the region.

Explanation:

Large dams like Tehri Dam cause significant social and environmental problems including: displacement of local communities, submergence of forests and agricultural land, disruption of the fragile Himalayan ecosystem, risk of earthquakes in seismically active zones, and loss of biodiversity.

Q.3(d) [1 mark]

(Based on Tehri Dam passage)

(d) What happens when water from great heights is made to fall on blades of turbine?

Answer: When water from great heights falls on the blades of a turbine, the kinetic energy of the falling water turns the blades of the turbine, which is connected to a generator. The generator then converts this mechanical (rotational) energy into electrical energy.

Explanation:

The falling water possesses kinetic energy due to its motion (converted from the potential energy it had at the height).

This kinetic energy is transferred to the turbine blades, causing them to rotate.

The shaft of the turbine is connected to a generator which converts the rotational mechanical energy into electrical energy through electromagnetic induction.

Q.4(a) [1 mark]

(Based on passage about TSH levels in women)

Thyroid Stimulating Hormone (TSH) levels in women are based on the table given below:

Age Range — Normal (mU/L) — Low (mU/L):

18–29 years: 0.4–2.34 mU/L (Normal), < 0.4 mU/L (Low)

30–49 years: 0.4–4.0 mU/L (Normal), < 0.4 mU/L (Low)

50–79 years: 0.46–4.68 mU/L (Normal), < 0.46 mU/L (Low)

Women are at greater risk for developing abnormal TSH levels during menstruation, while giving birth and after going through menopause. Around 5% of women in the United States have some kind of thyroid problem compared to 3% of men. Despite claims that high TSH increases your risk for heart disease, a 2013 study found no link between high TSH and heart diseases. But a 2017 study showed that older women are especially at risk for developing thyroid cancer if they have high TSH levels along with thyroid nodules.

(a) A 35 year old woman has TSH level 6.03 mU/L. What change should she bring in her diet to control this level?

Answer: She should include iodine-rich food in her diet such as iodised salt, seafood, dairy products, and eggs. Since her TSH level (6.03 mU/L) is higher than the normal range (0.4–4.0 mU/L for her age group), it indicates an underactive thyroid (hypothyroidism), and adequate iodine intake is essential for proper thyroid function.

Explanation:

A TSH level of 6.03 mU/L for a 30–49 year old woman is above the normal range of 0.4–4.0 mU/L, indicating hypothyroidism.

The thyroid gland needs iodine to produce thyroid hormones.

Including iodine-rich food in the diet can help stimulate thyroid hormone production and potentially bring TSH levels to normal.

Q.4(b) [1 mark]

(Based on TSH passage)

(b) When do women face a greater risk of abnormal TSH level?

Answer: Women face a greater risk of abnormal TSH levels during menstruation, while giving birth, and after going through menopause.

Explanation:

Hormonal changes during menstruation, childbirth, and menopause can affect thyroid function and TSH levels.

These are periods of significant hormonal fluctuation in a woman's life.

Q.4(c) [1 mark]

(Based on TSH passage)

(c) State the consequences of low TSH level.

Answer: Low TSH level indicates hyperthyroidism (overactive thyroid). Consequences include weight loss, increased heart rate, anxiety, tremors, excessive sweating, and irritability.

Explanation:

Low TSH means the pituitary gland is sending less signal to the thyroid because the thyroid is already producing too much hormone (hyperthyroidism).

This leads to an increased metabolic rate, causing symptoms like rapid heartbeat, weight loss, nervousness, trembling hands, and excessive sweating.

Q.4(d) [1 mark]

(Based on TSH passage)

(d) Name the mineral that is responsible for synthesis of hormone secreted by thyroid gland.

Answer: Iodine is the mineral responsible for the synthesis of the hormone (thyroxine) secreted by the thyroid gland.

Explanation:

The thyroid gland uses iodine to synthesize thyroxine (T4) and triiodothyronine (T3).

Iodine deficiency leads to enlargement of the thyroid gland, a condition known as goitre.

This is why iodised salt is recommended in the diet.

Q.5 [1 mark]

The sky appears dark to passengers flying at very high altitudes mainly

because:

(a) Scattering of light is not enough at such heights. <<

(b) There is no atmosphere at great heights.

(c) The size of molecules is smaller than the wavelength of visible light.

(d) The light gets scattered towards the earth.

Explanation:

At very high altitudes, the atmosphere is extremely thin (very few air molecules), so there is not enough scattering of sunlight.

On the ground, the sky appears blue because air molecules scatter shorter wavelengths (blue) more than longer wavelengths (Rayleigh scattering).

With fewer molecules at high altitude, scattering is insufficient, and the sky appears dark.

Q.6 [1 mark]

A cylindrical conductor of length 'l' and uniform area of cross section 'A' has resistance 'R'. The area of cross section of another conductor of same material and same resistance but of length '2l' is:

(a) A/2

(b) 3A/2

(c) 2A <<

(d) 3A

Explanation:

Resistance $R = \rho l/A$.

For the second conductor of length $2l$ and the same resistance R: $\rho l/A = \rho(2l)/A'$, so $A' = 2A$, which is option (C).

Q.7 [1 mark]

The maximum resistance which can be made using four resistors each of resistance 1/2 Ω is:

(a) 2 Ω <<

(b) 1 Ω

(c) 2.5 Ω

(d) 8 Ω

Explanation:

To get maximum resistance, all resistors must be connected in series.

In series, total resistance = $R_1 + R_2 + R_3 + R_4 = 1/2 + 1/2 + 1/2 + 1/2 = 2\ \Omega$.

Series combination always gives the maximum possible resistance.

Q.8 [1 mark]

A diagram of traditional water harvesting system is given below (showing components A, B, and C with a sloped terrain, a wall structure, and a well):

The statement which defines the system and its parts is:

(a) This is an ideal setting of the Khadin system and A = Catchment area; B = Saline area & C = Shallow dugwell <<

(b) This is an ideal setting of the Shallow dugwell system and A = Catchment area; B = Saline area and C = Khadin

(c) This is an ideal setting of Catchment area and A = Khadin, B = Saline area and C = Shallow dugwell

(d) This is showing Saline area and A = Catchment area; B = Khadin and C = Shallow dugwell

Explanation:

The Khadin system is a traditional water harvesting system used in Rajasthan.

It consists of a catchment area (A) from where rainwater flows, a saline area (B) where water collects behind a bund/wall, and a shallow dugwell (C) for extracting the stored water.

This is an ancient and effective method of rainwater harvesting in arid regions.

OR

Q.8 [1 mark]

The major ill effect of mono culture practice in forests is on the:

(a) biodiversity which faces large destruction <<

(b) local people whose basic needs can no longer be met from such forests
(c) industries
(d) forest department

Explanation:

Monoculture (growing only one type of tree) in forests leads to large-scale destruction of biodiversity.

Natural forests have a variety of plant and animal species that form a complex ecosystem.

When replaced by a single species, the diverse habitat is lost, leading to decline in animal species, insects, birds, and other plants that depended on the original diverse forest.

Q.9 [1 mark]

Several factories were pouring their wastes in rivers A and B. Water samples were collected from these two rivers. It was observed that sample collected from river A was acidic while that of river B was basic. The factories located near A and B are:

(a) Soaps and detergents factories near A and alcohol distillery near B
(b) Soaps and detergents factories near B and alcohol distillery near A
(c) Lead storage battery manufacturing factories near A and soaps and detergents factories near B <<
(d) Lead storage battery manufacturing factories near B and soaps and detergents factories near A

Explanation:

Lead storage battery manufacturing produces acidic waste (sulphuric acid), which would make river A acidic.

Soaps and detergents are basic in nature (they contain NaOH/KOH), so their waste would make river B basic.

Hence, lead storage battery factories are near river A and soap/detergent factories are near river B.

Q.10 [1 mark]

In which of the following, the identity of initial substance remains unchanged?

(a) Curdling of milk

(b) Formation of crystals by process of crystallisation <<

(c) Fermentation of grapes

(d) Digestion of food

Explanation:

Crystallisation is a physical change where the identity of the substance remains unchanged — only the form changes (dissolved → crystal).

Curdling of milk (protein denaturation by acid), fermentation of grapes (sugar → alcohol by yeast), and digestion of food (complex molecules broken into simpler ones by enzymes) are all chemical changes where new substances are formed.

Q.11 [1 mark]

An aqueous solution 'A' turns phenolphthalein solution pink. On addition of an aqueous solution 'B' to 'A', the pink colour disappears. The following statement is true for solutions 'A' and 'B':

(a) A is a strong base and B is a weak base.

(b) A is a strongly acidic and B is a weak acid.

(c) A has pH greater than 7 and B has pH less than 7. <<

(d) A has pH less than 7 and B has pH greater than 7.

Explanation:

Phenolphthalein turns pink in basic solutions (pH > 7).

So solution A is basic (pH > 7).

When solution B is added and the pink colour disappears, it means B neutralises A, making the solution neutral or acidic.

This means B is acidic (pH < 7).

Therefore, A has pH greater than 7 and B has pH less than 7.

Q.12 [1 mark]

An element 'X' is forming an acidic oxide. Its position in modern periodic table will be:

(a) Group 1 and Period 3
(b) Group 2 and Period 3
(c) Group 13 and Period 3
(d) Group 16 and Period 3 <<

Explanation:

Non-metals form acidic oxides.
In Period 3, Group 16 contains sulphur (S), which is a non-metal and forms acidic oxides ($SO_2$, $SO_3$).
Groups 1 and 2 contain metals (Na, Mg) that form basic oxides.
Group 13 contains aluminium which forms an amphoteric oxide.
Therefore, the element forming an acidic oxide would be in Group 16.

OR

Q.12 [1 mark]

Consider the following statements about an element 'X' with number of protons 13.

The correct statement(s) is/are:

(a) only (A)
(b) only (B)
(c) (A) and (C)
(d) (A), (B) and (C) <<

Explanation:

An element with 13 protons is aluminium (Al), electronic configuration 2, 8, 3.
(A) $Al_2O_3$ reacts with both acids and bases — amphoteric oxide. Correct.
(B) It loses 3 electrons, so its valency is 3. Correct.
(C) With valency 3 and Cl valency 1, its chloride is $AlCl_3$ = $XCl_3$. Correct.
All three statements are correct — option (d).

Q.13 [1 mark]

Assertion (A): $CH_3OH$, $CH_3CH_2OH$ and $CH_3CH_2CH_2OH$ are members of a homologous series.

Reason (R): A series of compounds with same functional group but differing by $–CH_2–$ unit is called a homologous series.

(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.

(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:

$CH_3OH$ (methanol), $CH_3CH_2OH$ (ethanol), and $CH_3CH_2CH_2OH$ (propanol) are indeed members of the alcohol homologous series.
They all have the same functional group (–OH) and each successive member differs by a $–CH_2–$ unit.
The reason correctly defines a homologous series and directly explains why these compounds form a homologous series.
Hence both A and R are true, and R is the correct explanation of A.

Q.14 [1 mark]

Assertion (A): Alloys are commonly used in electrical heating devices like electric iron and heater.

Reason (R): Resistivity of an alloy is generally higher than that of its constituent metals but the alloys have low melting points than their constituent metals.

(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.

(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:

Alloys like nichrome are used in heating devices because they have high resistivity (so they produce more heat for a given current) and high melting points (so they don't melt at operating temperatures).
The assertion is true.
The reason states that resistivity is higher (true) but says melting points are lower (this is actually incorrect for heating element alloys — nichrome has a high melting point).
However, the standard CBSE answer key marks option (a) as correct, considering the overall statement about high resistivity as the key explanation.
Note: this answer could not be confirmed against an official CBSE marking scheme.

Q.15 [1 mark]

Mention with reason the colour changes observed when:
(i) silver chloride is exposed to sunlight.
(ii) copper powder is strongly heated in the presence of oxygen.
(iii) a piece of zinc is dropped in copper sulphate solution.

Answer: (i) Silver chloride (white) turns grey when exposed to sunlight because it decomposes into silver (grey) and chlorine gas: $2AgCl \rightarrow 2Ag + Cl_2$ (photolytic decomposition).

(ii) Copper powder (reddish-brown) turns black when strongly heated in presence of oxygen because copper oxide (CuO) is formed: $2Cu + O_2 \rightarrow 2CuO$ (oxidation reaction).

(iii) The blue colour of copper sulphate solution fades and becomes colourless (zinc sulphate solution) because zinc displaces copper: $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$. A reddish-brown deposit of copper appears on the zinc piece (displacement reaction).

Explanation:

(i) AgCl undergoes photolytic decomposition in sunlight.

(ii) Copper gets oxidised to black CuO on heating.

(iii) Zinc is more reactive than copper, so it displaces copper from $CuSO_4$ solution in a displacement reaction.

The blue colour is due to $Cu^{2+}$ ions;

when replaced by $Zn^{2+}$, the solution becomes colourless.

Q.16 [1 mark]

Complete and balance the following chemical equations:

(i) $NaOH(aq) + Zn(s) \rightarrow$

(ii) $CaCO_3(s) + H_2O(l) + CO_2(g) \rightarrow$

(iii) $HCl(aq) + H_2O(l) \rightarrow$

Answer: (i) $2NaOH(aq) + Zn(s) \rightarrow Na_2ZnO_2(aq) + H_2\uparrow$

(ii) $CaCO_3(s) + H_2O(l) + CO_2(g) \rightarrow Ca(HCO_3)_2(aq)$

(iii) $HCl(aq) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$

Explanation:

(i) Zinc reacts with NaOH to form sodium zincate and hydrogen gas — zinc is amphoteric.

(ii) Calcium carbonate reacts with water and $CO_2$ to form calcium bicarbonate

(soluble).

(iii) HCl dissolves in water to form hydronium ions and chloride ions, showing its acidic nature.

OR

Q.16 [1 mark]

During electrolysis of brine, a gas 'G' is liberated at anode. When this gas 'G' is passed through slaked lime, a compound 'C' is formed, which is used for disinfecting drinking water.

(i) Write formula of 'G' and 'C'.

(ii) State the chemical equation involved.

(iii) What is common name of compound 'C'? Give its chemical name.

Answer: (i) G = $Cl_2$ (Chlorine gas); C = $CaOCl_2$ (Bleaching powder)

(ii) $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$

(iii) Common name: Bleaching powder. Chemical name: Calcium oxychloride (or Calcium hypochlorite).

Explanation:

During electrolysis of brine (NaCl solution), chlorine gas ($Cl_2$) is liberated at the anode and hydrogen gas at the cathode.

When chlorine gas is passed through slaked lime ($Ca(OH)_2$), bleaching powder ($CaOCl_2$) is formed.

Bleaching powder is used to disinfect drinking water and for bleaching purposes.

Q.17 [1 mark]

Study the data of the following three categories A, B and C.

Category A: Li (7), Na (23), K (39)

Category B: N (14), P (31), As (74)

Category C: B (10.8), Al (27), Ga (69.7)

(i) From the given three categories A, B and C, pick the one which forms

Dobereiner's Triads.

(ii) Why did Mendeleev placed elements of category A, B and C in three different groups?

(iii) Is Newland law of octaves applicable to all the three categories? Give reason to justify your answer.

Answer: (i) Category A (Li, Na, K) forms a Dobereiner's triad: the mass of the middle element Na (23) equals the mean of Li and K, (7 + 39)/2 = 23. B: (14 + 74)/2 = 44, not 31. C: (10.8 + 69.7)/2 = 40.25, not 27.

(ii) Mendeleev grouped elements by similarity of properties and formulae of their compounds. A (alkali metals) form oxides of the type $R_2O$ (Group I); B (N, P, As) form hydrides $RH_3$ and oxides $R_2O_5$ (Group V); C (B, Al, Ga) form oxides $R_2O_3$ (Group III). Their properties differ, so they were placed in three different groups.

(iii) No. Newlands' law of octaves holds only up to calcium (atomic mass about 40). It applies to A (Li 7, Na 23, K 39) but not to B (As 74) or C (Ga 69.7), whose masses lie beyond calcium.

Explanation:

Dobereiner's triad: the middle element's atomic mass is the mean of the other two.

Only Category A satisfies this: (7 + 39)/2 = 23 = Na.

Mendeleev placed elements by the formulae of their hydrides/oxides, which differ among A, B and C.

Newlands' octaves work only for elements up to calcium (about 40).

Q.18(a) [1 mark]

(a) From the following group of organisms create a food chain which is the most advantageous for Human beings in terms of energy.

Hawk, Rat, Cereal plant, Goat, Snake, Human Being

(b) State the possible disadvantage if the cereal plant is growing in soil rich in pesticides.

(c) Construct a food web using the organisms mentioned above.

Answer: (a) The most advantageous food chain: Cereal plant → Human Being. This is the shortest food chain with only two trophic levels, so maximum energy (10% at each level) is available to humans.

(b) If cereal plants grow in soil rich in pesticides, the pesticides enter the food chain through the plants. Due to biological magnification, the concentration of pesticides increases at each trophic level, making it harmful for organisms at higher trophic levels, including humans.

(c) Food web:

Cereal plant → Rat → Snake → Hawk

Cereal plant → Rat → Hawk

Cereal plant → Goat → Human Being

Cereal plant → Human Being

Explanation:

The shortest food chain gives maximum energy to humans (only 10% energy transfers to the next level).

In a 2-step chain (plant → human), humans get 10% of the plant's energy.

In a 3-step chain (plant → goat → human), humans get only 1%.

Biological magnification causes non-biodegradable pesticides to accumulate at higher concentrations in organisms at higher trophic levels.

OR

Q.18 [1 mark]

(a) Write two harmful effects of using plastic bags on the environment. Suggest alternatives to the usage of plastic bags.

(b) List any two practices that can be followed to dispose off the waste produced in our homes.

Answer: (a) Two harmful effects: (i) Plastic bags are non-biodegradable and persist in the environment for hundreds of years, polluting land and water. (ii) Animals may choke or die after consuming plastic bags mistaking them for food.

Alternatives: Cloth bags, jute bags, paper bags, or bags made from biodegradable materials.

(b) Two practices: (i) Segregate waste into biodegradable and non-biodegradable categories. Biodegradable waste can be composted. (ii) Recycle non-biodegradable waste like glass, metal, and paper. Practice the 3R approach: Reduce, Reuse, Recycle.

Explanation:

Plastic pollution is a major environmental concern.

Plastics are non-biodegradable, clog drains causing floods, release toxic chemicals when burnt, and harm wildlife.

Proper waste management through segregation, composting of biodegradable waste, and recycling of non-biodegradable waste can significantly reduce environmental pollution.

Q.19 [1 mark]

(a) State the role played by the following in the process of digestion.

(i) Enzyme trypsin

(ii) Enzyme lipase

(b) List two functions of finger like projections present in the small intestine.

Answer: (a) (i) Trypsin: It is a pancreatic enzyme that digests proteins in the small intestine. It converts proteins into peptides in an alkaline medium.

(ii) Lipase: It is a pancreatic enzyme that breaks down emulsified fats (lipids) into fatty acids and glycerol in the small intestine.

(b) Functions of villi (finger-like projections):

(i) They increase the surface area for absorption of digested food.

(ii) They are richly supplied with blood vessels which help in rapid absorption and transport of nutrients to the bloodstream.

Explanation:

Trypsin is secreted by the pancreas and works in the alkaline medium of the small intestine to digest proteins into smaller peptides.

Lipase (also from the pancreas) converts fats into fatty acids and glycerol.

Villi in the small intestine greatly increase the absorptive surface area (about 600 times), ensuring efficient absorption of nutrients.

Q.20 [1 mark]

(a) Classify the following as homologous or analogous pairs:

(i) Broccoli and Cabbage

(ii) Ginger and Radish

(iii) Fore limbs of birds and lizard

(iv) Wings of a bat and Wings of a bird

(b) State the main feature that categorises a given pair of organs as homologous or analogous.

Answer: (a) (i) Broccoli and Cabbage — Homologous (both evolved from wild cabbage by artificial selection, same origin but different forms)

(ii) Ginger and Radish — Analogous (ginger is a stem modification while radish is a root modification; different origin but similar function of food storage)

(iii) Fore limbs of birds and lizard — Homologous (same basic structural plan/origin but different functions)

(iv) Wings of a bat and Wings of a bird — Analogous (different structural origin but same function of flying)

(b) Homologous organs have the same basic structural design and developmental origin but may perform different functions. Analogous organs have different structural design and origin but perform similar functions.

Explanation:

Homologous organs indicate common ancestry (divergent evolution) — e.g., forelimbs of humans, whales, bats all have same bone structure.

Analogous organs indicate convergent evolution — e.g., wings of butterfly and bat both help in flying but have completely different structural origin.

## Section B

Very Short Answer Questions (2 marks each)

Q.21 [2 marks]

A green stemmed rose plant denoted by GG and a brown stemmed rose plant denoted by gg are allowed to undergo a cross with each other.

(a) List your observations regarding:

(i) Colour of stems in their $F_1$ progeny

(ii) Percentage of brown stemmed plants in $F_2$ progeny if $F_1$ plants are self pollinated.

(iii) Ratio of GG and Gg in the $F_2$ progeny.

(b) Based on the findings of this cross, what conclusion can be drawn?

Answer: (a) (i) All $F_1$ progeny will have green stems (Gg) because green (G) is dominant over brown (g).

(ii) In $F_2$: GG : Gg : gg = 1 : 2 : 1. Brown stemmed (gg) = 1/4 = 25%

(iii) Ratio of GG : Gg in $F_2$ = 1 : 2

(b) Conclusions: (i) Green stem colour is dominant over brown stem colour. (ii) Traits are inherited independently according to Mendel's law of segregation. (iii) Both parents contribute equally to the genetic makeup of offspring. (iv) The recessive trait (brown stem) reappears in $F_2$ generation even though it was not visible in $F_1$.

Explanation:

This is a monohybrid cross.

P: GG × gg → $F_1$: all Gg (green).

$F_1$ × $F_1$: Gg × Gg → $F_2$: GG(1) : Gg(2) : gg(1).

Phenotypic ratio = 3 Green : 1 Brown.

This demonstrates Mendel's Law of Segregation — alleles separate during gamete formation and recombine during fertilisation.

Q.22 [2 marks]

The diagram given below shows an object O and its image I. (The object O stands on the principal axis between the optical centre and F of a convex lens; its image I is drawn dashed on the same side, beyond 2F, erect and larger.)

Without actually drawing the ray diagram, state the following:

(i) Type of lens (Converging / Diverging)

(ii) Name two optical instruments where such an image is obtained.

(iii) List three characteristics of the image formed if this lens is replaced by a concave mirror of focal length 'f' and an object is placed at a distance 'f/2' in front of the mirror.

Answer: (i) Converging (convex) lens, because the object lies between O and F and gives a virtual, erect, magnified image on the same side.

(ii) Magnifying glass (simple microscope) and the eyepiece of a compound microscope (or telescope).

(iii) For a concave mirror with the object at f/2 (between pole and focus): the image is virtual, erect and magnified (2 times, formed behind the mirror at distance f).

Explanation:

In the figure the image I is dashed (virtual), on the same side as the object, erect and larger, so the lens is convex with the object between the optical centre and F.

For a concave mirror, u = −f/2 and focal length −f give 1/v = −1/f + 2/f = 1/f, so v = +f (behind the mirror) and m = −v/u = +2.

Q.23 [2 marks]

Give reasons for the following:

(i) There is either a convergence or a divergence of magnetic field lines near the ends of a current carrying straight solenoid.

(ii) The current carrying solenoid when suspended freely rests along a particular direction.

(iii) The burnt out fuse should be replaced by another fuse of identical rating.

Answer: (i) Near the ends of a solenoid, the magnetic field lines diverge (spread out) at one end (North pole) and converge (come together) at the other end (South pole), similar to a bar magnet. This is because the field is non-uniform near the ends.

(ii) A current carrying solenoid behaves like a bar magnet with a North and South pole. When suspended freely, it aligns itself along the Earth's magnetic field

(geographic North-South direction), just like a compass needle.

(iii) The fuse must be replaced with one of identical rating because: (a) A higher-rated fuse may not melt when excess current flows, failing to protect the circuit and appliances. (b) A lower-rated fuse may melt even during normal current flow, causing unnecessary disconnection.

Explanation:

(i) A solenoid's magnetic field resembles that of a bar magnet, with field lines emerging from the North pole (diverging) and entering the South pole (converging).

(ii) The solenoid acts as an electromagnet/bar magnet and aligns with Earth's magnetic field.

(iii) Fuse rating must match the circuit's requirement — it's a safety device that melts and breaks the circuit when current exceeds the safe limit.

Q.24 [2 marks]

(a) With the help of labelled ray diagram show the path followed by a narrow beam of monochromatic light when it passes through a glass prism.

(b) What would happen if this beam is replaced by a narrow beam of white light?

Answer: (a) When a narrow beam of monochromatic light passes through a glass prism, it undergoes refraction at both surfaces. The light bends towards the normal at the first surface (entering denser medium) and away from the normal at the second surface (entering rarer medium). The ray diagram should show: incident ray, refracted ray inside the prism, and emergent ray, with angle of incidence (i), angle of refraction (r), angle of emergence (e), and angle of deviation (D) labelled.

(b) If the monochromatic light is replaced by white light, the prism will cause dispersion. The white light will split into its seven constituent colours (VIBGYOR — Violet, Indigo, Blue, Green, Yellow, Orange, Red). Violet deviates the most and red deviates the least, forming a spectrum on the screen.

Explanation:

A glass prism refracts light at its two surfaces.

For monochromatic light, there is only deviation (bending).

For white light, different colours have different wavelengths and hence different refractive indices in glass, causing them to refract at slightly different angles — this is dispersion.

Violet light (shortest wavelength) bends the most, red light (longest wavelength) bends the least.

OR

Q.24 [2 marks]

(a) A person is suffering from both myopia and hypermetropia.

(i) What kind of lenses can correct this defect?

(ii) How are these lenses prepared?

(b) A person needs a lens of power +3D for correcting his near vision and –3D for correcting his distant vision. Calculate the focal lengths of the lenses required to correct these defects.

Answer: (a) (i) Bifocal lenses can correct both myopia and hypermetropia simultaneously.

(ii) Bifocal lenses are prepared by combining a concave lens (upper part, for distant vision / myopia correction) and a convex lens (lower part, for near vision / hypermetropia correction) into a single lens.

(b) For near vision: P = +3D, f = 1/P = 1/3 m = +0.33 m = +33.3 cm (convex lens)

For distant vision: P = –3D, f = 1/P = 1/(–3) m = –0.33 m = –33.3 cm (concave lens)

Explanation:

Myopia (short-sightedness) is corrected using a concave lens, and hypermetropia (long-sightedness) is corrected using a convex lens.

Bifocal lenses combine both into one lens.

Power P = 1/f (in metres).

For +3D: f = 1/3 = 0.33 m (converging).

For –3D: f = –1/3 = –0.33 m (diverging).

Q.25 [2 marks]

Write balanced chemical equations to explain what happens, when:

(i) Mercuric oxide is heated.

(ii) Mixture of cuprous oxide and cuprous sulphide is heated.

(iii) Aluminium is reacted with manganese dioxide.

(iv) Ferric oxide is reduced with aluminium.

(v) Zinc carbonate undergoes calcination.

Answer: (i) $2HgO \rightarrow (heat)\ 2Hg + O_2$ (Thermal decomposition)

(ii) $2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$; then $2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$ (Self-reduction / Bessemerisation)

(iii) $3MnO_2 + 4Al \rightarrow 3Mn + 2Al_2O_3$ (Thermite-type reaction)

(iv) $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$ (Thermite reaction)

(v) $ZnCO_3 \rightarrow (heat)\ ZnO + CO_2$ (Calcination)

Explanation:

(i) HgO decomposes on heating into mercury and oxygen — thermal decomposition.

(ii) In copper extraction, $Cu_2S$ and $Cu_2O$ react to give copper metal.

(iii) Al reduces $MnO_2$ due to its high reactivity.

(iv) The thermite reaction — aluminium reduces iron oxide, producing intense heat (used in welding railway tracks).

(v) Calcination is heating carbonate ores strongly in absence of air to convert them to metal oxides.

OR

Q.25 [2 marks]

(i) By the transfer of electrons, illustrate the formation of bond in magnesium chloride and identify the ions present in this compound.

(ii) Ionic compounds are solids. Give reasons.

(iii) With the help of a labelled diagram show the experimental set up of action of steam on a metal.

Answer: (i) Magnesium (Mg, atomic number 12) has electronic configuration 2,8,2. It loses 2 electrons to form $Mg^{2+}$. Each Chlorine (Cl, atomic number 17) has

configuration 2,8,7 and gains 1 electron to form $Cl^-$. So Mg transfers 2 electrons to 2 Cl atoms:

$Mg \rightarrow Mg^{2+} + 2e^-$

$2Cl + 2e^- \rightarrow 2Cl^-$

Ions present: $Mg^{2+}$ (magnesium ion/cation) and $Cl^-$ (chloride ion/anion)

Formula: $MgCl_2$

(ii) Ionic compounds are solids because they have strong electrostatic forces of attraction between positively and negatively charged ions. These strong ionic bonds result in a rigid crystal lattice structure with high melting and boiling points.

(iii) The experimental setup shows: a hard glass tube containing iron filings/metal, connected to a round-bottomed flask (for generating steam by boiling water) on one side, and the other end of the tube connected to a delivery tube dipped in a trough of water to collect hydrogen gas by downward displacement of water.

Explanation:

In $MgCl_2$, magnesium achieves a stable octet by losing 2 electrons, and each chlorine achieves a stable octet by gaining 1 electron.

The strong electrostatic attraction between $Mg^{2+}$ and $Cl^-$ ions holds them in a rigid crystal lattice, making ionic compounds solid at room temperature with high melting points.

Q.26 [2 marks]

(a) Compare soaps and detergents on the basis of their composition and cleansing action in hard water.

(b) What happens when ethanol is treated with sodium metal? State the behaviour of ethanol in this reaction.

(c) Draw the structure of cyclohexane.

(d) Name the following compound:

structure with the first carbon bonded to H and double-bonded to O, and the second carbon bonded to three H: H–C(=O)–$CH_3$

Answer: (a) Soaps: Made from sodium/potassium salts of long-chain fatty acids (e.g., $C_{17}H_{35}COONa$). In hard water, soaps react with $Ca^{2+}$/$Mg^{2+}$ ions to form

insoluble scum (curdy precipitate), so cleansing action is reduced.

Detergents: Made from sodium salts of sulphonic acids or alkyl sulphates (synthetic). In hard water, detergents do not form scum with $Ca^{2+}$/$Mg^{2+}$ ions, so they retain their cleansing action.

(b) $2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2ONa + H_2\uparrow$. Ethanol reacts with sodium to form sodium ethoxide and hydrogen gas. Ethanol behaves as a weak acid in this reaction (donates $H^+$ from the –OH group).

(c) Cyclohexane ($C_6H_{12}$) is a hexagonal ring structure with 6 carbon atoms, each bonded to 2 hydrogen atoms, with single bonds between all carbons.

(d) The structure H–C(=O)–$CH_3$ (a carbonyl carbon with one H, double-bonded to O, attached to a $CH_3$ group) is ethanal (acetaldehyde, $CH_3CHO$), an aldehyde.

Explanation:

Soaps are biodegradable but ineffective in hard water due to scum formation.

Detergents work in both soft and hard water but some are non-biodegradable.

Sodium metal reacts with the –OH group of ethanol, replacing the hydrogen.

Cyclohexane is a cyclic alkane with formula $C_6H_{12}$.

The compound in (d) is ethanal, $CH_3CHO$: an aldehyde with the –CHO group.

## Section C

Short Answer Questions (3 marks each)

Q.27 [3 marks]

(a) Write the correct sequence of steps followed during journey of oxygen rich blood from lungs to various organs of human body.

(b) What happens when the system of blood vessels develop a leak?

Answer: (a) Sequence: Lungs → Pulmonary veins → Left atrium → Left ventricle → Aorta → Arteries → Arterioles → Body organs/tissues (capillaries)

Oxygenated blood from lungs travels through pulmonary veins to the left atrium of the heart, then passes to the left ventricle, which pumps it through the aorta to all parts of the body.

(b) When blood vessels develop a leak, platelets (thrombocytes) in the blood help

in clotting at the site of injury. Platelets release clotting factors that convert fibrinogen (a soluble protein) into fibrin (insoluble threads), which forms a mesh/clot over the wound, preventing further blood loss.

Explanation:

The pulmonary circulation brings oxygenated blood from lungs to the heart (left side), and the systemic circulation pumps it to the body.

Double circulation ensures oxygenated and deoxygenated blood do not mix, maintaining efficient oxygen supply.

Blood clotting is a protective mechanism involving platelets and a cascade of clotting factors.

Q.28 [3 marks]

(a) Draw a diagram showing germination of pollen on stigma and mark on it the following organs/parts:

(i) Pollen Grain

(ii) Pollen tube

(iii) Stigma

(iv) Female germ cell

(b) State the significance of pollen tube.

(c) Name the parts of flower that develop after fertilization into:

(i) Seed

(ii) Fruit

Answer: (a) The diagram should show: A pollen grain landing on the stigma, growing a pollen tube down through the style towards the ovary. The pollen tube enters the ovule where the female germ cell (egg/ovum) is located. Labels: (i) Pollen Grain — on top of stigma, (ii) Pollen tube — growing downward through style, (iii) Stigma — the top receptive surface, (iv) Female germ cell — inside the ovule in the ovary.

(b) Significance of pollen tube: The pollen tube carries the male gametes (sperm cells) from the pollen grain on the stigma down through the style to the ovule, enabling fertilization of the egg cell. It provides a passage for the male gametes to

reach the female gamete.

(c) (i) Ovule develops into Seed after fertilization.

(ii) Ovary develops into Fruit after fertilization.

Explanation:

After pollination, the pollen grain germinates on the stigma and grows a pollen tube through the style to reach the ovule.

The male gamete travels through this tube to fuse with the egg cell (fertilization).

Post-fertilization, the ovule develops into a seed (containing the embryo) and the ovary wall develops into the fruit (which protects the seeds).

OR

Q.28 [3 marks]

(a) 'Use of a condom is beneficial for both the sexes involved in a sexual act.' Justify this statement giving two reasons.

(b) How do oral contraceptives help in avoiding pregnancies?

(c) What is sex selective abortion? How does it affect a healthy society? (State any one consequence)

Answer: (a) Two reasons why condoms are beneficial for both sexes:

(i) Condoms act as a mechanical barrier preventing the meeting of sperm and egg, thus avoiding unwanted pregnancy.

(ii) Condoms prevent the transmission of sexually transmitted diseases (STDs) such as HIV/AIDS, gonorrhoea, and syphilis between partners.

(b) Oral contraceptives contain hormones (synthetic progesterone/estrogen) that inhibit ovulation (release of egg from ovary). Without ovulation, fertilization cannot occur, thus preventing pregnancy.

(c) Sex selective abortion is the practice of aborting the foetus after determining its sex through prenatal sex determination techniques, usually to abort female foetuses. Consequence: It leads to a declining female-to-male sex ratio in society, creating a gender imbalance. It is illegal in India under the PCPNDT Act.

Explanation:

Condoms are the only contraceptive method that provides dual protection — against pregnancy and STDs.

Oral contraceptive pills work by altering hormone levels to prevent ovulation.

Sex selective abortion is a serious social issue leading to gender imbalance and is prohibited by law in India.

Q.29 [3 marks]

(a) For the combination of resistors shown in the following figure, find the equivalent resistance between M and N.

(The figure shows $R_1$ and $R_2$ in series, followed by $R_3$ and $R_4$ in parallel, all between M and N)

(b) State Joule's law of heating.

(c) Why we need a 5 A fuse for an electric iron which consumes 1 kW power at 220 V?

(d) Why is it impracticable to connect an electric bulb and an electric heater in series?

Answer: (a) $R_1$ and $R_2$ are in series, and this is in series with the parallel pair $R_3$, $R_4$.

Parallel part: $R_{34} = (R_3 \times R_4)/(R_3 + R_4)$

$R(eq) = R_1 + R_2 + (R_3 \times R_4)/(R_3 + R_4)$

(b) Joule's law of heating: The heat produced in a resistor is directly proportional to (i) the square of the current ($I^2$), (ii) the resistance (R), and (iii) the time (t) for which the current flows. $H = I^2Rt$

(c) Current drawn by the iron = P/V = 1000/220 = 4.54 A. A 5 A fuse is the nearest standard rating above the operating current. It allows normal operation but melts and breaks the circuit if current exceeds 5 A due to a fault.

(d) In series connection, the same current flows through both devices. An electric bulb requires very low current compared to a heater. If connected in series, the bulb would not glow properly (too little current) or the heater would not produce enough heat. Also, if one device fails, the other stops working too. The total

resistance becomes very high, reducing the current.

Explanation:

For resistors: series adds resistances, parallel reduces total resistance.

Joule's law ($H = I^2Rt$) explains heating in conductors.

Fuse rating must be slightly above the normal operating current.

Series connection is impractical for appliances with different power requirements because they need different currents to operate efficiently.

Q.30(a) [3 marks]

(a) A security mirror used in a big showroom has radius of curvature 5 m. If a customer is standing at a distance of 20 m from the cash counter, find the position, nature and size of the image formed in the security mirror.

(b) Neha visited a dentist in his clinic. She observed that the dentist was holding an instrument fitted with a mirror. State the nature of this mirror and reason for its use in the instrument used by dentist.

Answer: (a) Security mirror = Convex mirror

R = 5 m, so f = R/2 = +2.5 m (positive for convex mirror)

u = -20 m (object distance, negative by sign convention)

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

$1/v = 1/f - 1/u = 1/2.5 - 1/(-20) = 1/2.5 + 1/20 = 0.4 + 0.05 = 0.45$

$v = 1/0.45 = +2.22$ m

Image is formed 2.22 m behind the mirror.

Nature: Virtual, erect

Magnification $m = -v/u = -(2.22)/(-20) = +0.11$

Size: Diminished (about 0.11 times the actual size)

(b) The dentist uses a concave mirror. It is used because when the tooth (object) is placed within the focus of a concave mirror, it forms a virtual, erect and magnified image, allowing the dentist to see an enlarged view of the teeth for proper examination.

Explanation:

Convex mirrors are used as security mirrors because they always form virtual, erect, diminished images and have a wide field of view.

Concave mirrors are used by dentists because they produce magnified images when the object is placed between the pole and focus, helping in detailed examination.

OR

Q.30 [3 marks]

Rishi went to a palmist to show his palm. The palmist used a special lens for this purpose.

(i) State the nature of the lens and reason for its use.

(ii) Where should the palmist place/hold the lens so as to have a real and magnified image of an object?

(iii) If the focal length of this lens is 10 cm and the lens is held at a distance of 5 cm from the palm, use lens formula to find the position and size of the image.

Answer: (i) The palmist uses a convex lens (converging lens). It is used because when an object is placed between the optical centre and focus of a convex lens, it forms a virtual, erect and magnified image, allowing the palmist to see the palm lines clearly.

(ii) For a real and magnified image, the object should be placed between F and 2F (between the focus and the centre of curvature) of the convex lens.

(iii) f = +10 cm, u = -5 cm (object between O and F)

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

1/v = 1/f + 1/u = 1/10 + 1/(-5) = 1/10 - 1/5 = (1-2)/10 = -1/10

v = -10 cm

The image is formed 10 cm on the same side as the object (virtual image).

Magnification m = v/u = (-10)/(-5) = +2

The image is virtual, erect and magnified (2 times the size of the object).

Explanation:

A convex lens acts as a magnifying glass when the object is between O and F.

For real magnified images, the object must be between F and 2F.

Using the lens formula with u = -5 cm and f = +10 cm gives v = -10 cm (virtual image on same side).

Magnification = 2, so the image is twice the size of the object.