CBSE 2020 Science — Set 1 — Answer Key

English Medium

Time Allowed: 3 Hours | Maximum Marks: 80

General Instructions:

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

Section A

Multiple Choice Questions (1 mark each)

Q.1 [1 mark]

Name a cyclic unsaturated carbon compound.

Answer: Benzene (C_6H_6) is a cyclic unsaturated carbon compound. It has a hexagonal ring structure with alternating double bonds.

Explanation:

Benzene is the simplest aromatic hydrocarbon.

It is cyclic (ring-shaped) and unsaturated (contains double bonds / delocalized electrons).

Other examples include cyclohexene.

Q.2 [1 mark]

The change in magnetic field lines in a coil is the cause of induced electric current in it. Name the underlying phenomenon.

Answer: Electromagnetic Induction

Explanation:

Electromagnetic induction is the phenomenon in which a changing magnetic field in a coil induces an electric current (EMF) in it.

This was discovered by Michael Faraday.

Q.3(a) [1 mark]

The growing size of the human population is a cause of concern for all people. The rate of birth and death in a given population will determine its size. Reproduction is the process by which organisms increase their population. The process of sexual maturation for reproduction is gradual and takes place while general body growth is still going on. Some degree of sexual maturation does not necessarily mean that the mind or body is ready for sexual acts or for having and bringing up children. Various contraceptive devices are being used by human beings to control the size of population.

(a) List two common signs of sexual maturation in boys and girls.

Answer: Boys: Growth of facial hair (moustache and beard), deepening of voice, broadening of shoulders. Girls: Development of breasts, onset of menstruation, widening of hips.

Explanation:

Sexual maturation (puberty) involves hormonal changes.

In boys, testosterone causes facial hair growth, voice deepening, and muscle development.

In girls, estrogen causes breast development, menstruation, and hip widening.

Q.3(b) [1 mark]

The growing size of the human population is a cause of concern for all people. Various contraceptive devices are being used by human beings to control the size of population.

(b) What is the result of reckless female foeticide?

Answer: Reckless female foeticide leads to a decline in the child sex ratio (fewer girls compared to boys), which causes a serious imbalance in the sex ratio of the population.

Explanation:

Female foeticide is the illegal practice of aborting a foetus after determining it is female.

It leads to a declining sex ratio, social imbalance, and is a punishable offence under the Pre-Conception and Pre-Natal Diagnostic Techniques (PCPNDT) Act.

Q.3(c) [1 mark]

The growing size of the human population is a cause of concern for all people. Various contraceptive devices are being used by human beings to control the size of population.

(c) Which contraceptive method changes the hormonal balance of the body?

Answer: Oral contraceptive pills (oral pills) change the hormonal balance of the body.

Explanation:

Oral contraceptive pills contain synthetic hormones (estrogen and progesterone) that prevent ovulation by changing the hormonal balance.
They inhibit the release of eggs from the ovary.

Q.3(d) [1 mark]

The growing size of the human population is a cause of concern for all people. The rate of birth and death in a given population will determine its size.

(d) Write two factors that determine the size of a population.

Answer: The two factors that determine the size of a population are: (i) Birth rate and (ii) Death rate.

Explanation:

Population size depends on birth rate (natality) and death rate (mortality).
If birth rate exceeds death rate, population increases;
if death rate exceeds birth rate, population decreases.

Q.4(a) [1 mark]

Human body is made up of five important components, of which water is the main component. Food as well as potable water are essential for every human being. The food is obtained from plants through agriculture. Pesticides are being used extensively for a high yield in the fields. These pesticides are absorbed by the plants from the soil along with water and minerals and from the water bodies these pesticides are taken up by the aquatic animals and plants. As these chemicals are not biodegradable, they get accumulated progressively at each trophic level. The maximum

concentration of these chemicals gets accumulated in our bodies and greatly affects the health of our mind and body.

(a) Why is the maximum concentration of pesticides found in human beings?

Answer: Humans occupy the top of the food chain. Non-biodegradable pesticides get accumulated at each trophic level through the process of biological magnification (biomagnification). Since humans are at the highest trophic level, the maximum concentration of pesticides is found in their bodies.

Explanation:

Biological magnification is the increase in concentration of harmful non-biodegradable chemicals at successive trophic levels of a food chain.

As energy flows from lower to higher trophic levels, the concentration of pesticides increases progressively.

Q.4(b) [1 mark]

Pesticides are absorbed by the plants from the soil along with water and minerals. As these chemicals are not biodegradable, they get accumulated progressively at each trophic level.

(b) Give one method which could be applied to reduce our intake of pesticides through food to some extent.

Answer: Washing fruits and vegetables thoroughly before eating, or eating organically grown food can reduce our intake of pesticides.

Explanation:

Other methods include peeling fruits and vegetables before consumption, using biological pest control methods instead of chemical pesticides in agriculture, and promoting organic farming.

Q.4(c) [1 mark]

Various steps in a food chain represent:

(a) Food web
(b) Trophic level <<
(c) Ecosystem
(d) Biomagnification

Explanation:
Each step in a food chain where transfer of energy occurs is called a trophic level.
Producers form the first trophic level, primary consumers form the second, secondary consumers form the third, and so on.

Q.4(d) [1 mark]

With regard to various food chains operating in an ecosystem, man is a:

(a) Consumer <<
(b) Producer
(c) Producer and consumer
(d) Producer and decomposer

Explanation:
In an ecosystem, man is a consumer.
Humans cannot make their own food (not producers) and do not decompose dead matter (not decomposers).
Humans consume food produced by plants (herbivore role) or eat other animals (carnivore/omnivore role).

Q.5 [1 mark]

Calcium oxide reacts vigorously with water to produce slaked lime.
$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq)$
This reaction can be classified as:

Which of the following is a correct option?

(a) (A) and (C)
(b) (C) and (D)
(c) (A), (C) and (D)

(d) (A) and (B) <<

Explanation:

$CaO + H_2O \rightarrow$

$Ca(OH)_2$ is a combination reaction (two substances combine to form one product) and an exothermic reaction (large amount of heat is released during the reaction).

It is not endothermic (heat is released, not absorbed) and not an oxidation reaction.

OR

Q.5 [1 mark]

When hydrogen sulphide gas is passed through a blue solution of copper sulphate, a black precipitate of copper sulphide is obtained and the sulphuric acid so formed remains in the solution. The reaction is an example of a:

(a) Combination reaction

(b) Displacement reaction

(c) Decomposition reaction

(d) Double displacement reaction <<

Explanation:

$H_2S + CuSO_4 \rightarrow CuS\downarrow + H_2SO_4$.

This is a double displacement reaction because the ions of the two reactants exchange partners.

Cu^{2+} pairs with S^{2-} to form CuS (precipitate) and H^+ pairs with SO_4^{2-} to form H_2SO_4.

Q.6 [1 mark]

In a double displacement reaction such as the reaction between sodium sulphate solution and barium chloride solution:

The correct option is:

(a) (B) and (D)

(b) (A) and (C)

(c) only (B)

(d) (B), (C) and (D) <<

Explanation:

$Na_2SO_4 + BaCl_2 \rightarrow BaSO_4\downarrow + 2NaCl$.

In this double displacement reaction: ions are exchanged (B is correct, not atoms), a precipitate ($BaSO_4$) is produced (C is correct), and $BaSO_4$ is an insoluble salt (D is correct).

So (B), (C) and (D) are all correct.

Q.7 [1 mark]

Baking soda is a mixture of:

(a) Sodium carbonate and acetic acid

(b) Sodium carbonate and tartaric acid

(c) Sodium hydrogen carbonate and tartaric acid <<

(d) Sodium hydrogen carbonate and acetic acid

Explanation:

Baking powder (often confused with baking soda in the question context) is a mixture of sodium hydrogen carbonate ($NaHCO_3$, i.e., baking soda) and tartaric acid.

When heated or dissolved in water, the tartaric acid reacts with $NaHCO_3$ to produce CO_2 gas which causes bread/cake to rise.

Q.8 [1 mark]

The chemical formula for plaster of Paris is:

(a) $CaSO_4 \cdot 2H_2O$

(b) $CaSO_4 \cdot H_2O$

(c) $CaSO_4 \cdot \frac{1}{2}H_2O$ <<

(d) $2CaSO_4 \cdot H_2O$

Explanation:

Plaster of Paris is calcium sulphate hemihydrate with the formula $CaSO_4 \cdot \frac{1}{2}H_2O$.

It is obtained by heating gypsum ($CaSO_4 \cdot 2H_2O$) at 373 K.

When mixed with water, it sets into a hard mass (gypsum) again, which makes it useful for making casts and moulds.

Q.9 [1 mark]

The laws of reflection hold true for:

(a) plane mirrors only
(b) concave mirrors only
(c) convex mirrors only
(d) all reflecting surfaces <<

Explanation:

The laws of reflection (angle of incidence equals angle of reflection, and the incident ray, reflected ray, and normal all lie in the same plane) are universal and hold true for all reflecting surfaces — plane mirrors, concave mirrors, convex mirrors, and any other polished surface.

OR

Q.9 [1 mark]

When an object is kept within the focus of a concave mirror, an enlarged image is formed behind the mirror. This image is:

(a) real
(b) inverted
(c) virtual and inverted
(d) virtual and erect <<

Explanation:

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

This is why concave mirrors are used as shaving/makeup mirrors.

Q.10 [1 mark]

At the time of short circuit, the electric current in the circuit:

(a) varies continuously
(b) does not change
(c) reduces substantially

(d) increases heavily <<

Explanation:

During a short circuit, the live wire and neutral wire come in direct contact, reducing the resistance of the circuit to nearly zero.

By Ohm's law (I = V/R), when resistance R becomes very small, the current I increases enormously (heavily).

This large current can cause overheating, sparks, and fire.

OR

Q.10 [1 mark]

Two bulbs of 100 W and 40 W are connected in series. The current through the 100 W bulb is 1 A. The current through the 40 W bulb will be:

(a) 0.4 A

(b) 0.6 A

(c) 0.8 A

(d) 1 A <<

Explanation:

In a series circuit, the current remains the same through all components.

Since the current through the 100 W bulb is 1 A, the current through the 40 W bulb will also be 1 A.

In series connection, current is constant while voltage divides across the components.

Q.11 [1 mark]

Which one of the following is responsible for the sustenance of underground water?

(a) Loss of vegetation cover

(b) Diversion for high water demanding crops

(c) Pollution from urban wastes

(d) Afforestation <<

Explanation:

Afforestation (planting trees) helps in the sustenance of underground water.

Tree roots hold the soil and allow rainwater to percolate into the ground, recharging the groundwater table.

Loss of vegetation, diversion for crops, and pollution all deplete or contaminate groundwater.

Q.12 [1 mark]

Incomplete combustion of coal and petroleum:

The correct option is:

(a) (A) and (B)

(b) (A) and (D) <<

(c) (B) and (C)

(d) (C) and (D)

Explanation:

Incomplete combustion of coal and petroleum produces poisonous gases like carbon monoxide (CO) and unburnt carbon particles, which increase air pollution.

It does NOT increase efficiency (it reduces it) and does NOT reduce global warming (it contributes to it).

So (A) and (D) are correct.

Q.13 [1 mark]

Assertion (A): Esterification is a process in which a sweet smelling substance is produced.

Reason (R): When esters react with sodium hydroxide an alcohol and sodium salt of carboxylic acid are obtained.

Select the correct option:

(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.

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(c) A is true but R is false

(d) A is false but R is true

Explanation:

Assertion is true: Esterification produces esters which have sweet/fruity smell.

Reason is also true: Esters react with NaOH to give alcohol and sodium salt of carboxylic acid (saponification).

However, saponification (R) does not explain esterification (A) — they are different reactions.

Hence both are true but R is not the correct explanation of A.

Q.14 [1 mark]

Assertion (A): In the process of nuclear fission, the amount of nuclear energy generated by the fission of an atom of uranium is so tremendous that it produces 10 million times the energy produced by the combustion of an atom of carbon from coal.

Reason (R): The nucleus of a heavy atom such as uranium, when bombarded with low energy neutrons, splits apart into lighter nuclei. The mass difference between the original nucleus and the product nuclei gets converted to tremendous energy.

Select the correct option:

(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.

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(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 statements are true.

Nuclear fission of uranium produces about 10 million times more energy than burning carbon (A is true).

The reason correctly explains this: when uranium is bombarded with slow neutrons, it splits into lighter nuclei and the mass defect (difference) is converted into energy according to $E = mc^2$ (R is true and correctly explains A).

Q.15 [1 mark]

1 g of copper powder was taken in a china dish and heated. What change takes place on heating? When hydrogen gas is passed over this heated substance, a visible change is seen in it. Give the chemical equations of reactions, the name and the colour of the products formed in each case.

Answer: On heating copper powder:

$2Cu + O_2 \rightarrow 2CuO$ (black copper oxide is formed; copper turns from reddish-brown to black).

When hydrogen gas is passed over heated CuO:

$CuO + H_2 \rightarrow Cu + H_2O$ (the black CuO is reduced back to reddish-brown copper metal, and water is formed).

The first reaction is oxidation of copper, and the second is a redox reaction (reduction of CuO and oxidation of H_2).

Explanation:

Copper is oxidised to black CuO on heating in air.

When H_2 is passed over hot CuO, it acts as a reducing agent — CuO is reduced back

to reddish-brown Cu.

This demonstrates a redox reaction where CuO is reduced and H_2 is oxidised.

Q.16 [1 mark]

List the important products of the Chlor-alkali process. Write one important use of each.

Answer: The Chlor-alkali process involves electrolysis of brine (NaCl solution):

$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$

Products and uses:

1. Sodium hydroxide (NaOH) — Used in making soaps and detergents, degreasing metals.
2. Chlorine gas (Cl_2) — Used in water purification, making PVC, disinfectants and CFCs.
3. Hydrogen gas (H_2) — Used as a fuel, in the manufacture of ammonia (for fertilisers), and in hydrogenation of oils.

Explanation:

The Chlor-alkali process is the electrolysis of aqueous sodium chloride (brine).

At the anode, chlorine gas is produced.

At the cathode, hydrogen gas is produced.

NaOH solution is formed near the cathode.

OR

Q.16 [1 mark]

How is washing soda prepared from sodium carbonate? Give its chemical equation. State the type of this salt. Name the type of hardness of water which can be removed by it.

Answer: Washing soda is prepared by recrystallisation of sodium carbonate:

$Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3 \cdot 10H_2O$ (washing soda)

Sodium carbonate is obtained by heating baking soda:

$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

Type of salt: It is a basic salt (sodium salt of a weak acid, carbonic acid, and a strong base, NaOH).
It can remove both temporary and permanent hardness of water by converting soluble calcium and magnesium salts into insoluble carbonates.

Explanation:
Washing soda ($Na_2CO_3 \cdot 10H_2O$) is the decahydrate of sodium carbonate.
It is a basic salt that can soften hard water by precipitating Ca^{2+} and Mg^{2+} ions as insoluble carbonates.

Q.17 [1 mark]

3 mL of ethanol is taken in a test tube and warmed gently in a water bath. A 5% solution of alkaline potassium permanganate is added first drop by drop to this solution, then in excess.
(i) How is 5% solution of $KMnO_4$ prepared?
(ii) State the role of alkaline potassium permanganate in this reaction. What happens on adding it in excess?
(iii) Write the chemical equation of this reaction.

Answer: (i) 5% solution of $KMnO_4$ is prepared by dissolving 5 g of $KMnO_4$ in 95 mL of water (or in 100 mL of solution).

(ii) Alkaline $KMnO_4$ acts as an oxidising agent. It oxidises ethanol to ethanoic acid (acetic acid). When added in excess, the colour of $KMnO_4$ persists (does not get decolourised) as there is no more ethanol left to be oxidised.

(iii) $CH_3CH_2OH + 2[O] \rightarrow CH_3COOH + H_2O$
(Ethanol is oxidised to ethanoic acid in the presence of alkaline $KMnO_4$ / acidified $K_2Cr_2O_7$)

Explanation:

Alkaline $KMnO_4$ is a strong oxidising agent that converts alcohols to carboxylic acids.

The purple colour of $KMnO_4$ gets decolourised as it oxidises ethanol.

When added in excess, the purple colour persists indicating completion of reaction.

Q.18 [1 mark]

A squirrel is in a scary situation. Its body has to prepare for either fighting or running away. State the immediate changes that take place in its body so that the squirrel is able to either fight or run.

Answer: When a squirrel faces a scary situation, the adrenal glands secrete adrenaline (epinephrine) into the blood. The immediate changes are:

1. Heart rate increases to supply more oxygen to muscles.
2. Blood supply to the digestive system and skin decreases and is diverted to skeletal muscles.
3. Breathing rate increases to take in more oxygen.
4. Blood pressure rises.
5. The muscles become tense and ready for action.
6. Pupils dilate for better vision.

These changes prepare the body for the 'fight or flight' response.

Explanation:

The fight or flight response is controlled by the hormone adrenaline secreted by the adrenal glands.

It prepares the body for emergency situations by increasing heart rate, breathing rate, and blood flow to muscles.

OR

Q.18 [1 mark]

Why is chemical communication better than electrical impulses as a means of communication between cells in a multi-cellular organism?

Answer: Chemical communication (hormones) is better than electrical impulses in certain situations because:

1. Hormones can reach all cells of the body through the blood, not just those connected by nerves.
2. Hormones can produce widespread, long-lasting effects on multiple target organs simultaneously.
3. Electrical impulses act on specific points (nerve-muscle junctions) and are short-lived, while hormonal effects persist for longer duration.
4. Chemical communication can regulate slow processes like growth, metabolism, and reproduction which do not need instant signalling.
5. Hormones can affect cells that are far away from the source (endocrine glands).

Explanation:

Electrical impulses travel fast but have limited reach (only along nerve fibres).
Hormones travel through blood and can affect distant organs for prolonged periods, making them suitable for long-term regulation like growth, development, and metabolism.

Q.19 [1 mark]

Define the term pollination. Differentiate between self pollination and cross pollination. What is the significance of pollination?

Answer: Pollination is the process of transfer of pollen grains from the anther of a stamen to the stigma of a carpel (pistil).

Self pollination: Transfer of pollen grains from the anther to the stigma of the same flower or another flower on the same plant. It does not require pollinators.

Cross pollination: Transfer of pollen grains from the anther of a flower on one plant to the stigma of a flower on another plant of the same species. It requires agents like wind, water, insects, birds, etc.

Significance: Pollination leads to fertilisation and formation of seeds and fruits, ensuring the continuation of the plant species. Cross pollination introduces genetic

variation, making offspring better adapted to the environment.

Explanation:

Pollination is essential for sexual reproduction in flowering plants.

Self pollination maintains genetic purity while cross pollination introduces variation.

Both are critical for seed and fruit formation.

Q.20 [1 mark]

What are homologous structures? Give an example. Is it necessary that homologous structures always have a common ancestor? Justify your answer.

Answer: Homologous structures are organs or body parts in different organisms that have the same basic structural plan and origin (same embryonic origin) but may perform different functions.

Example: The forelimbs of a human (hand for grasping), a whale (flipper for swimming), a bat (wing for flying), and a horse (leg for running) all have the same basic bone structure (humerus, radius, ulna, carpals, metacarpals, phalanges) but are adapted for different functions.

Yes, homologous structures indicate that the organisms have a common ancestor. They provide evidence of divergent evolution, where organisms with a common ancestor have evolved differently to adapt to different environments. The similarity in basic structure despite different functions suggests inheritance from a common ancestral form.

Explanation:

Homologous structures are key evidence for evolution.

They show divergent evolution — different organisms evolving from a common ancestor but adapting their body structures for different functions over time.

Section B

Very Short Answer Questions (2 marks each)

Q.21 [2 marks]

Why is Tyndall effect shown by colloidal particles? State four instances of observing the Tyndall effect.

Answer: Tyndall effect is shown by colloidal particles because the particles in a colloid are large enough (1 nm to 100 nm) to scatter the beam of light passing through it. The size of colloidal particles is comparable to the wavelength of visible light, enabling them to scatter light.

Four instances of observing the Tyndall effect:

1. When sunlight passes through a canopy of a dense forest, the path of light becomes visible due to scattering by tiny water droplets and dust particles in the air (mist).
2. When a beam of light enters a dark room through a small hole, the path of light is visible due to scattering by dust particles in the air.
3. The headlights of a car appear to form visible beams in foggy conditions due to scattering by water droplets.
4. When sunlight passes through the glass of water containing a few drops of milk, the path of light becomes visible.

Explanation:

The Tyndall effect is the scattering of light by colloidal particles.

It is used to distinguish between true solutions (no scattering) and colloids (scattering observed).

The particles must be of appropriate size to scatter visible light.

OR

Q.21 [2 marks]

Differentiate between a glass slab and a glass prism. What happens when a narrow beam of (i) a monochromatic light, and (ii) white light passes through (a) a glass slab and (b) a glass prism?

Answer: Difference: A glass slab has two parallel refracting surfaces (opposite

faces are parallel), while a glass prism has two non-parallel refracting surfaces inclined at an angle (the angle of the prism).

(i) Monochromatic light:

(a) Glass slab: The light ray undergoes refraction at both surfaces and emerges parallel to the incident ray with a lateral displacement. No dispersion occurs.

(b) Glass prism: The light ray undergoes refraction and deviates from its original path (bends towards the base). No dispersion occurs as it is a single wavelength.

(ii) White light:

(a) Glass slab: The light passes through with lateral displacement but no dispersion (all colours recombine as the surfaces are parallel). The emergent ray is white.

(b) Glass prism: The light undergoes dispersion and splits into its seven component colours (VIBGYOR — violet, indigo, blue, green, yellow, orange, red) forming a spectrum. Violet deviates the most and red the least.

Explanation:

A glass slab causes lateral displacement without dispersion because the two refracting surfaces are parallel.

A prism causes both deviation and dispersion because the surfaces are non-parallel.

Dispersion occurs because different wavelengths refract by different amounts.

Q.22 [2 marks]

Draw a labelled diagram to show (i) reddish appearance of the sun at the sunrise or the sunset and (ii) white appearance of the sun at noon when it is overhead.

Answer: At sunrise/sunset: The sun is near the horizon, so sunlight has to travel a longer distance through the atmosphere. The shorter wavelengths (blue, violet) get scattered away by air molecules (Rayleigh scattering), and only longer wavelengths (red, orange) reach our eyes. Hence the sun appears reddish.

At noon: The sun is overhead, so sunlight travels a shorter distance through the atmosphere. Less scattering of shorter wavelengths occurs, and light of all colours reaches our eyes. Hence the sun appears white (or yellowish-white).

Diagram should show:
(i) Sun at horizon → long path through atmosphere → blue light scattered away → red light reaches observer.
(ii) Sun overhead → short path through atmosphere → all colours reach observer → white appearance.

Explanation:

The colour of the sun changes due to Rayleigh scattering of light by atmospheric particles.

Shorter wavelengths scatter more.

At sunrise/sunset, the longer path causes maximum scattering of blue light, leaving red.

At noon, the shorter path means less scattering and all colours reach us.

Q.23 [2 marks]

A V-I graph for a nichrome wire is given below. What do you infer from this graph? Draw a labelled circuit diagram to obtain such a graph.

Answer: From the V-I graph (which shows a straight line passing through the origin):

1. The current (I) is directly proportional to the potential difference (V). This verifies Ohm's law: V = IR.
2. The nichrome wire is an ohmic conductor (obeys Ohm's law).
3. The resistance of the wire is constant (given by the slope of the V-I graph, R = V/I).
4. The graph is a straight line, confirming that the ratio V/I remains constant.

Circuit diagram should include:

- A battery (cell) as the source of EMF
- A rheostat (variable resistance) to vary the current
- An ammeter connected in series to measure current
- A voltmeter connected in parallel across the nichrome wire to measure potential difference
- A key/switch to complete the circuit
- The nichrome wire as the resistance under study.

Explanation:

A linear V-I graph passing through the origin confirms Ohm's law.
The slope gives resistance.
The circuit requires a battery, ammeter (series), voltmeter (parallel across wire), rheostat, key, and the nichrome wire.

Q.24(a) [2 marks]

(a) Write the mathematical expression for Joule's law of heating.

Answer: $H = I^2Rt$

Where:
H = Heat produced (in joules)
I = Current flowing through the conductor (in amperes)
R = Resistance of the conductor (in ohms)
t = Time for which current flows (in seconds)

Explanation:

Joule's law of heating states that the heat produced in a conductor is directly proportional to the square of the current (I^2), the resistance (R), and the time (t) for which current flows.
$H = I^2Rt$.

Q.24(b) [2 marks]

(b) Compute the heat generated while transferring 96000 coulomb of charge in two hours through a potential difference of 40 V.

Answer: Given: Q = 96000 C, t = 2 hours, V = 40 V

Heat generated H = V × Q = 40 × 96000 = 3,840,000 J = 3840 kJ

Check: I = Q/t = 96000/7200 = 40/3 A, so H = V I t = 40 × (40/3) × 7200 = 3,840,000 J

Explanation:
Using H = VIt or H = VQ.
Since Q = It, we can directly use H = VQ = 40 × 96000 = 3,840,000 J = 3840 kJ = 3.84 MJ.

Q.25 [2 marks]

Carbon cannot reduce the oxides of sodium, magnesium and aluminium to their respective metals. Why? Where are these metals placed in the reactivity series? How are these metals obtained from their ores? Take an example to explain the process of extraction along with chemical equations.

Answer: Carbon cannot reduce the oxides of sodium, magnesium and aluminium because these metals are more reactive than carbon. They are placed at the top of the reactivity series (above carbon). Carbon is not a strong enough reducing agent to reduce their oxides.

These highly reactive metals are obtained by electrolytic reduction (electrolysis) of their molten ores.

Example — Extraction of Aluminium:
Aluminium is extracted from its ore bauxite ($Al_2O_3 \cdot 2H_2O$) by electrolytic reduction.

Step 1: Bauxite is purified to get alumina (Al_2O_3).
Step 2: Alumina is dissolved in molten cryolite (Na_3AlF_6) to lower the melting point.
Step 3: Electrolysis of molten alumina:

At cathode: $Al^{3+} + 3e^- \rightarrow Al$ (aluminium metal deposited)

At anode: $2O^{2-} \rightarrow O_2 + 4e^-$ (oxygen gas released)

Example — Extraction of Sodium:

$2NaCl(molten) \rightarrow 2Na + Cl_2$ (by electrolysis)

At cathode: $Na^+ + e^- \rightarrow Na$

At anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

Explanation:

Metals at the top of the reactivity series (K, Na, Ca, Mg, Al) cannot be reduced by carbon.

They require electrolytic reduction of their molten salts/ores.

Carbon can only reduce oxides of metals below it in the reactivity series.

Q.26 [2 marks]

The position of certain elements in the Modern Periodic Table are shown below.

Group →	1	2	3 to 12	13	14	15	16	17	18
Period 1	G								H
Period 2		A		I			B		C
Period 3		D			E				F

Using the above table answer the following questions giving reasons in each case:

(i) Which element will form only covalent compounds?

(ii) Which element is a non-metal with valency 2?

(iii) Which element is a metal with valency 2?

(iv) Out of H, C and F which has largest atomic size?

(v) To which family does H, C and F belong?

Answer: (i) E (Group 14) forms only covalent compounds. It has 4 valence

electrons, so it can neither easily lose nor gain 4 electrons and instead shares them.

(ii) B (Group 16) is a non-metal with valency 2. It has 6 valence electrons and needs 2 more to complete its octet.

(iii) D (Group 2) is a metal with valency 2. It has 2 valence electrons which it readily loses.

(iv) F has the largest atomic size. H, C and F are all in Group 18, and atomic size increases down a group because the number of shells increases; F is in Period 3, C in Period 2 and H in Period 1.

(v) H, C and F are all in Group 18, so they belong to the noble gas (inert gas) family.

Explanation:

Group number decides valency and family: Group 14 elements share electrons, Group 16 non-metals have valency 2, Group 2 metals have valency 2.

H, C and F lie in Group 18 (noble gases); size increases down a group as shells are added.

OR

Q.26 [2 marks]

Define atomic size. Give its unit of measurement. In the modern periodic table what trend is observed in the atomic radius in a group and a period and why is it so?

Answer: Atomic size (atomic radius) is defined as the distance from the centre of the nucleus of an atom to its outermost shell of electrons. It is measured in picometres (pm) or nanometres (nm). 1 pm = 10^{-12} m.

Trend in a Group (top to bottom): Atomic size INCREASES.

Reason: As we go down a group, the number of shells (energy levels) increases. Each new period adds a new shell, so the outermost electrons are farther from the nucleus. Although nuclear charge also increases, the effect of additional shells dominates, and the atomic radius increases.

Trend in a Period (left to right): Atomic size DECREASES.
Reason: As we move across a period from left to right, the atomic number increases (more protons in the nucleus), so the nuclear charge increases. However, electrons are being added to the same shell (valence shell). The increased nuclear charge pulls the electrons closer to the nucleus, and the atomic radius decreases.

Explanation:
Atomic size depends on the number of electron shells and the nuclear charge.
Down a group, more shells are added, increasing size.
Across a period, increasing nuclear charge with same number of shells decreases size.

Q.27(a) [3 marks]

(a) Why is there a difference in the rate of breathing between aquatic organisms and terrestrial organisms? Explain.
(b) Draw a diagram of human respiratory system and label — pharynx, trachea, lungs, diaphragm and alveolar sac on it.

Answer: (a) Aquatic organisms breathe faster than terrestrial organisms because:
- The amount of dissolved oxygen in water is much less compared to the amount of oxygen in the atmosphere.
- Water contains only about 0.7% dissolved oxygen whereas air contains about 21% oxygen.
- Since the oxygen content in water is low, aquatic organisms like fish have to breathe faster (move more water over their gills) to obtain sufficient oxygen for respiration.

- Terrestrial organisms have access to oxygen-rich air and hence breathe at a comparatively slower rate.

(b) The diagram of the human respiratory system should show and label:
- Pharynx (throat region connecting nasal cavity to larynx)
- Trachea (windpipe, reinforced with cartilage rings)
- Lungs (pair of spongy organs in the thoracic cavity)
- Diaphragm (muscular sheet at the base of the thoracic cavity)
- Alveolar sac (tiny balloon-like structures at the end of bronchioles where gas exchange occurs)

Explanation:
The rate of breathing depends on the availability of oxygen in the medium.
Water has far less dissolved oxygen than air, so aquatic organisms must breathe faster.
The respiratory system diagram should show the complete pathway from pharynx to alveoli.

OR

Q.27 [3 marks]

OR

(a) Name the organs that form the excretory system in human beings.
(b) Describe in brief how urine is produced in human body.

Answer: (a) The organs of the human excretory system are:
1. A pair of kidneys (main excretory organs)
2. A pair of ureters (tubes connecting kidneys to bladder)
3. Urinary bladder (stores urine)
4. Urethra (tube through which urine is expelled)

(b) Formation of urine:
1. Filtration: Blood enters the kidney through the renal artery and reaches the glomerulus (a cluster of capillaries) in the Bowman's capsule of the nephron.

Blood is filtered under high pressure. Useful substances like glucose, amino acids, salts, and water along with waste products like urea and uric acid pass into the Bowman's capsule. Blood cells and proteins remain in the blood.

2. Selective reabsorption: As the filtrate passes through the tubular part of the nephron, useful substances like glucose, amino acids, salts, and most of the water are reabsorbed back into the blood capillaries surrounding the tubule.

3. Collection: The remaining liquid (urine) containing urea, excess salts, and water is collected in the collecting duct, which carries it to the ureter, then to the urinary bladder, and finally expelled through the urethra.

Explanation:

The excretory system removes nitrogenous waste from the body.

The kidney is the main organ with nephrons as functional units.

Urine formation involves three steps: glomerular filtration, tubular reabsorption, and collection.

Section C

Short Answer Questions (3 marks each)

Q.28 [3 marks]

(a) What is the law of dominance of traits? Explain with an example.

(b) Why are the traits acquired during the life time of an individual not inherited? Explain.

Answer: (a) Law of Dominance: When two organisms with contrasting forms of a trait (pure/homozygous) are crossed, the trait that appears in the F1 generation is called dominant and the trait that is suppressed is called recessive.

Example: When a pure tall pea plant (TT) is crossed with a pure dwarf pea plant (tt):

- F1 generation: All plants are tall (Tt) — tallness is dominant over dwarfness.

- F2 generation (F1 × F1): TT : Tt : tt = 1:2:1 (genotypic ratio)
  Phenotypic ratio = 3 tall : 1 dwarf
- The recessive trait (dwarf) reappears in F2 generation.

(b) Traits acquired during the lifetime of an individual are NOT inherited because:
- Acquired traits involve changes in non-reproductive (somatic) cells only.
- These changes do not cause any change in the DNA of the germ cells (reproductive cells/gametes).
- Since hereditary information is passed through DNA in germ cells, changes in somatic cells cannot be passed on to the next generation.
- Example: If a person develops muscular body by exercise, this trait will not be passed to offspring because it does not alter the genes in the sex cells.

Explanation:
The law of dominance was given by Gregor Mendel.
Dominant traits mask recessive traits in the F1 generation.
Acquired traits are not inherited because they do not change the DNA in reproductive cells (germ line).

Q.29 [3 marks]

Draw a ray diagram in each of the following cases to show the formation of image, when the object is placed:
(i) between optical centre and principal focus of a convex lens.
(ii) anywhere in front of a concave lens.
(iii) at 2F of a convex lens.
State the signs and values of magnifications in the above mentioned cases (i) and (ii).

Answer: (i) Object between O and F of a convex lens:
- Image: On the same side as the object, virtual, erect, and enlarged.
- Magnification: Positive and greater than 1 ($m > +1$). Positive sign indicates the image is erect and virtual.

(ii) Object anywhere in front of a concave lens:

- Image: Between F and O on the same side as the object, virtual, erect, and diminished.
- Magnification: Positive and less than 1 ($0 < m < +1$). Positive sign indicates the image is erect and virtual.

(iii) Object at 2F of a convex lens:

- Image: At 2F on the other side, real, inverted, and same size as the object.
- Magnification: Negative and equal to -1 ($m = -1$). Negative sign indicates the image is real and inverted.

Ray diagrams should show:

- Two rays from the top of the object (one parallel to principal axis, refracted through F; one through optical centre, going straight).
- The intersection of refracted rays (or their extensions for virtual images) gives the image position.

Explanation:

For convex lens: object between O and F gives virtual, erect, enlarged image.
Object at 2F gives real, inverted, same-size image.
For concave lens: image is always virtual, erect, and diminished regardless of object position.

OR

Q.29 [3 marks]

An object 4.0 cm in size, is placed 25.0 cm in front of a concave mirror of focal length 15.0 cm.

(i) At what distance from the mirror should a screen be placed in order to obtain a sharp image?

(ii) Find the size of the image.

(iii) Draw a ray diagram to show the formation of image in this case.

Answer: Given: object size h = +4.0 cm, u = -25.0 cm, f = -15.0 cm

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

1/v = 1/f - 1/u = -1/15 + 1/25 = (-5 + 3)/75 = -2/75

v = -37.5 cm

(i) The screen should be placed 37.5 cm in front of the mirror (same side as the object).

(ii) Magnification m = -v/u = -(-37.5)/(-25) = -1.5

Image size h' = m × h = -1.5 × 4.0 = -6.0 cm

The image is 6.0 cm in size, real, inverted and enlarged.

(iii) Ray diagram: the object is between F (15 cm) and C (30 cm). The image forms beyond C (at 37.5 cm), real, inverted and enlarged. Draw a ray parallel to the principal axis reflecting through F, and a ray through C returning along its own path; they meet beyond C.

Explanation:

Mirror formula with sign convention gives v = -37.5 cm.

Since the object lies between F and C (15 cm < 25 cm < 30 cm), the image is real, inverted and enlarged, beyond C.

Q.30 [3 marks]

(a) What is an electromagnet? List any two uses.

(b) Draw a labelled diagram to show how an electromagnet is made.

(c) State the purpose of soft iron core used in making an electromagnet.

(d) List two ways of increasing the strength of an electromagnet if the material of the electromagnet is fixed.

Answer: (a) An electromagnet is a type of temporary magnet that is made by winding an insulated copper wire around a soft iron core and passing electric

current through it. It behaves as a magnet only when current flows through the coil.

Two uses:
1. Used in electric bells, electric motors, and loudspeakers.
2. Used in cranes for lifting heavy iron/steel objects in scrap yards and industries.

(b) Diagram should show: A soft iron core (nail/rod) with insulated copper wire wound around it in the form of a coil (solenoid), connected to a battery and a switch. Labels: soft iron core, insulated copper wire coil, battery, switch/key.

(c) Soft iron is used as the core because:
- Soft iron gets magnetised easily and strongly when current flows (high permeability).
- Soft iron loses its magnetism quickly when the current is switched off (low retentivity/coercivity), making it a temporary magnet which can be turned on and off.

(d) Two ways to increase the strength of an electromagnet:
1. Increase the number of turns of the coil wound around the core.
2. Increase the current flowing through the coil.

Explanation:
An electromagnet is a temporary magnet whose strength can be controlled.
Soft iron is chosen for its high permeability and low retentivity.
Strength depends on number of turns, current, and core material.