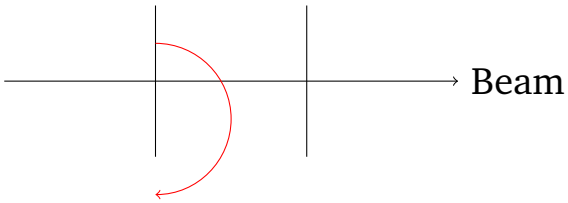
JEECUP Group A Chemistry Sample Paper – 4

Duration: 45 Minutes **Maximum Marks: 100**

Instructions

- This paper contains **25** Multiple Choice Questions (Single Correct).
- Each correct answer carries **+4 marks**. No marks will be deducted for incorrect answers. Unattempted questions carry **0** marks.
- Only **one** option is correct for each question.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. A beam of electrons is passed through a magnetic field as shown below. Which particle will show maximum deflection?



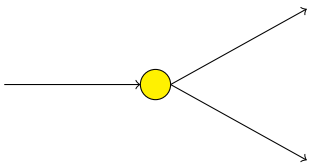
(A) Proton

(B) Neutron

(C) Electron

(D) Alpha particle

Q2. In Rutherford's scattering experiment, most alpha particles passed undeflected because:



(A) Nucleus is heavy

(B) Atom is mostly empty space

(C) Electrons repel alpha particles

(D) Neutrons absorb alpha particles

Q3. Across a period in the periodic table, which trend is correct?

Na	Mg	Al

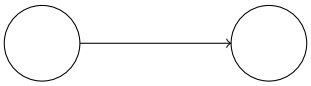
(A) Atomic size increases

(B) Ionization energy decreases

(C) Metallic character decreases

(D) Reactivity increases

Q4. Bond formation between atoms occurs mainly due to:



(A) Nuclear force

(B) Electrostatic attraction

(C) Gravitational force

(D) Magnetic force

Q5. The bond formed between Na and Cl is:

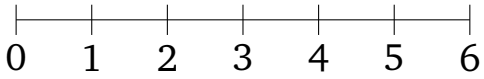
(A) Covalent

(B) Ionic

(C) Metallic

(D) Hydrogen

Q6. A solution has pH = 2. It is:



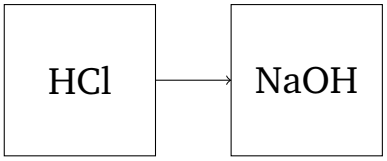
(A) Neutral

(B) Basic

(C) Strong acid

(D) Weak base

Q7. When HCl reacts with NaOH, the product formed is:



(A) Salt + water

(B) Only salt

(C) Only water

(D) Acid + base

Q8. Zn displaces Cu from $CuSO_4$ because:

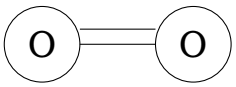
(A) Cu is more reactive

(B) Zn is more reactive

(C) Both equal

(D) Cu is gas

Q9. The bond in O_2 molecule is:



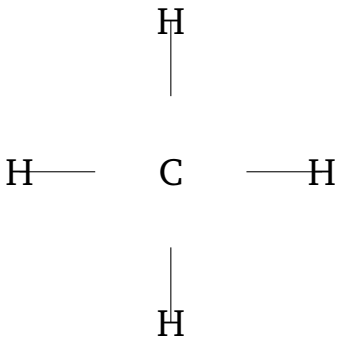
(A) Single bond

(B) Double bond

(C) Triple bond

(D) Ionic bond

Q10. The geometry of CH_4 molecule is:



(A) Linear

(B) Trigonal planar

(C) Tetrahedral

(D) Square planar

Q11. Which quantum number defines the shape of orbital?

(A) Principal quantum number

(B) Azimuthal quantum number

(C) Magnetic quantum number

(D) Spin quantum number

Q12. Isotopes of an element differ in:

(A) Number of protons

(B) Number of electrons

(C) Number of neutrons

(D) Valency

Q13. In a balanced chemical equation, law followed is:

(A) Conservation of mass

(B) Conservation of energy

(C) Avogadro law

(D) Boyle law

Q14. Which metal is most reactive in the series?

(A) Fe

(B) Zn

(C) K

(D) Cu

Q15. During electrolysis, oxidation occurs at:

(A) Cathode

(B) Anode

(C) Electrolyte

(D) Salt bridge

Q16. Strong acids are completely ionized in:

(A) Water

(B) Alcohol

(C) Benzene

(D) Solid state

Q17. Common salt is chemically known as:

(A) NaOH

(B) NaCl

(C) KCl

(D) $CaCO_3$

Q18. Rusting of iron requires:

(A) Oxygen only

(B) Water only

(C) Oxygen and water

(D) CO_2

Q19. Hydrocarbons contain:

(A) Carbon and hydrogen

(B) Carbon and oxygen

(C) Hydrogen and oxygen

(D) Only carbon

Q20. Complete combustion of fuel produces:

(A) CO

(B) CO_2 and H_2O

(C) C

(D) SO_2

Q21. The s-block elements are found in:

(A) Group 1 and 2

(B) Group 13–18

(C) Transition metals

(D) Inner transition metals

Q22. Electronic configuration of Na (11) is:

(A) 2,8,1

(B) 2,7,2

(C) 2,8,2

(D) 2,6,3

Q23. Which pair are isotopes?

(A) C-12 and C-14

(B) Na and K

(C) H and He

(D) O and N

Q24. Balancing chemical equations is based on:

(A) Law of definite proportions

(B) Law of conservation of mass

(C) Law of multiple proportions

(D) Dalton law

Q25. Haber process is used for production of:

(A) Sulfuric acid

(B) Ammonia

(C) Nitric acid

(D) Hydrochloric acid

Detailed Solutions

Q1.

Solution

Concept: The deflection of a charged particle in a magnetic field is governed by the magnetic force (Lorentz force):

$$\vec{F} = q(\vec{v} \times \vec{B})$$

The magnitude of this force is $F = |q|vB\sin\theta$. According to Newton's second law, the acceleration of the particle is:

$$a = \frac{F}{m} = \frac{|q|vB\sin\theta}{m}$$

Thus, the acceleration (which determines the degree of deflection) is directly proportional to the charge-to-mass ratio (q/m) of the particle:

$$\text{Deflection} \propto \frac{q}{m}$$

Solution: Compare charge-to-mass ratios (q/m) (taking e as elementary charge and $1\,\text{u}$ as mass unit):

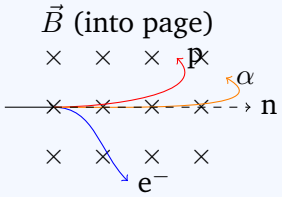
(a) **Electron (e^-):** $|q| = e,\ m = \frac{1}{1836}\,\text{u} \Rightarrow \frac{q}{m} \approx 1836\,(e/\text{u})$

(b) **Proton (p):** $|q| = e,\ m = 1\,\text{u} \Rightarrow \frac{q}{m} \approx 1\,(e/\text{u})$

(c) **Neutron (n):** $q = 0 \Rightarrow \frac{q}{m} = 0$

(d) **Alpha (α):** $|q| = 2e,\ m = 4\,\text{u} \Rightarrow \frac{q}{m} \approx 0.5\,(e/\text{u})$

Conclusion: Electron has the highest q/m ratio, hence maximum deflection.



Final Answer: Electron

Answer: (C)

Go Back to Question 1

Q2.

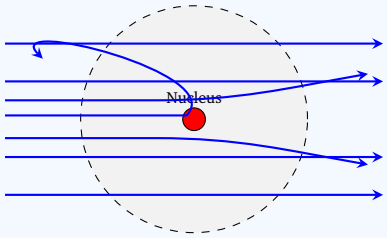
Solution

Concept: In 1911, Ernest Rutherford performed the alpha particle scattering experiment by bombarding a thin gold foil with energetic alpha particles (He^{2+}). Observations from this experiment helped build the nuclear model of the atom.

Solution: During the experiment, Rutherford observed that:

- Observation 1: Most of the alpha particles passed straight through the gold foil undeflected.
- Observation 2: A small fraction of alpha particles were deflected through small angles.
- Observation 3: A very tiny fraction (about 1 in 20,000) bounced back (deflected by nearly $180°$).

Since the vast majority of the alpha particles experienced no force and passed undeflected, it was concluded that most of the space inside the atom is empty. The massive positive charge (nucleus) is concentrated in an extremely small volume at the center of the atom.



Hence, most alpha particles passed undeflected because the atom is mostly empty space.

Final Answer: Atom is almost empty space

Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept: Periodic trends are specific patterns in the properties of chemical elements found in the periodic table. As we move across a period (from left to right):

- The number of protons (nuclear charge) increases.
- Electrons are added to the same main energy level, meaning shielding remains relatively constant.
- Consequently, the effective nuclear charge (Z_{eff}) acting on outer valence electrons increases.

Solution: Let us evaluate each of the options based on the increasing effective nuclear charge from left to right across a period:

(A) **Atomic size increases:** Incorrect. Because the effective nuclear charge increases, the nucleus pulls the electron cloud closer, causing the atomic size to *decrease*.

(B) **Ionization energy decreases:** Incorrect. As the nucleus binds the valence electrons more tightly, it requires more energy to remove an electron. Thus, ionization energy *increases*.

(C) **Metallic character decreases:** Correct. Metallic character is the tendency of an atom to lose electrons. Since ionization energy increases and atomic size decreases, it becomes harder for atoms to lose electrons. Therefore, metallic character *decreases* (elements transition from metals to metalloids and non-metals).

(D) **Reactivity increases:** Incorrect. Reactivity first decreases for metals (as they lose electrons less readily) and then increases for non-metals (as they gain electrons more readily).

Across a Period (Left to Right) $\longrightarrow$

- Nuclear charge increases
- Atomic size decreases
- Ionization energy increases
- **Metallic character decreases**

Thus, the correct trend across a period is that metallic character decreases.

Final Answer: Metallic character decreases

Answer: (C)

Go Back to Question 3

Q4.

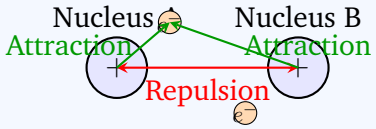
Solution

Concept: The interaction between atoms to form chemical bonds is fundamentally an electromagnetic phenomenon. Atoms consist of positively charged nuclei and negatively charged electrons.

Solution: As two atoms approach each other, electrostatic forces come into play:

- **Attractive forces** occur between the nucleus of one atom and the electrons of another.
- **Repulsive forces** occur between the nuclei of both atoms, and also between the electrons of both atoms.

A chemical bond forms when the system reaches a state of minimum potential energy, which happens when the electrostatic attractive forces overcome the repulsive forces.



Nuclear forces operate only over subatomic distances (10^{-15} m), while gravitational and magnetic forces are too weak to form stable chemical structures. Therefore, bond formation occurs mainly due to electrostatic attraction.

Final Answer: Electrostatic attraction

Answer: (B)

Go Back to Question 4

Q5.

Solution

Concept: Chemical bonds are classified based on the mechanism of electron interaction between atoms:

- **Ionic bond:** Formed by the complete transfer of one or more electrons from one atom (typically a metal) to another (typically a non-metal).
- **Covalent bond:** Formed by the sharing of electron pairs between atoms.

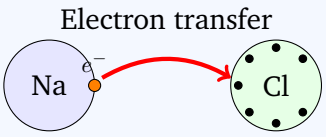
Solution: Sodium (Na) is an alkali metal (Group 1) with an electronic configuration of $2, 8, 1$. It has one valence electron and a low ionization energy, making it highly electropositive. Chlorine (Cl) is a halogen (Group 17) with an electronic configuration of $2, 8, 7$. It has seven valence electrons and a high electron affinity, making it highly electronegative.

To achieve a stable octet configuration:
1. Sodium loses its valence electron to form a sodium cation:

$$\text{Na} \rightarrow \text{Na}^+ + e^-$$

2. Chlorine gains this electron to form a chloride anion:

$$\text{Cl} + e^- \rightarrow \text{Cl}^-$$



The electrostatic force of attraction between the oppositely charged ions (Na^+ and Cl^-) holds them together, forming an ionic bond.

Final Answer: Ionic

Answer: (B)

Go Back to Question 5

Q6.

Solution

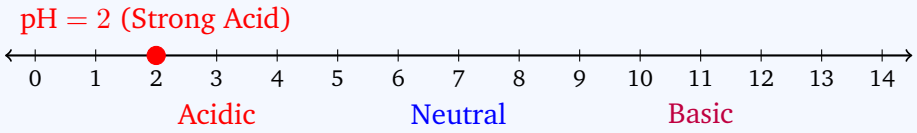
Concept: The pH scale is a logarithmic scale used to specify the acidity or basicity of an aqueous solution. It is defined mathematically as:

$$\text{pH} = -\log_{10}[\text{H}^+]$$

Solution: At room temperature (25°C):

- pH < 7 represents an acidic solution.
- pH $= 7$ represents a neutral solution.
- pH > 7 represents a basic (or alkaline) solution.

The lower the pH value below 7, the higher the concentration of hydrogen ions (H^+), indicating a stronger acid. A pH of 2 represents a very high hydrogen ion concentration (10^{-2} M), classifying the solution as a strong acid.



Therefore, a solution with pH $= 2$ is a strong acid.

Final Answer: Strong acid

Answer: (C)

Go Back to Question 6

Q7.

Solution

Concept: When an acid reacts with a base, they undergo a neutralization reaction. The hydrogen ions (H^+) from the acid combine with the hydroxide ions (OH^-) from the base to form water (H_2O), while the remaining ions combine to form an ionic salt.

$$\text{Acid} + \text{Base} \rightarrow \text{Salt} + \text{Water}$$

Solution: Hydrochloric acid (HCl) is a strong acid, and sodium hydroxide (NaOH) is a strong base. When mixed in aqueous solution, they react as follows:

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

Acid (HCl) + Base (NaOH) → Salt (NaCl) + Water (H_2O)

The ionic product NaCl (sodium chloride) is a standard neutral salt, and H_2O is water. Thus, the products formed are a salt and water.

Final Answer: Salt + water

Answer: (A)

Go Back to Question 7

Q8.

Solution

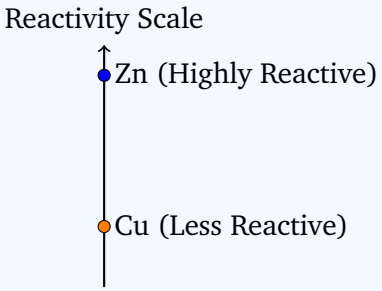
Concept: A single displacement reaction is a chemical reaction in which a more reactive element displaces a less reactive element from its compound. The relative reactivity of metals is determined by the metal reactivity (or activity) series.

Solution: In the reactivity series, metals are arranged in descending order of their chemical reactivity (their tendency to lose electrons):

$$\text{K} > \text{Na} > \text{Ca} > \text{Mg} > \text{Al} > \mathbf{Zn} > \text{Fe} > \text{Pb} > [\text{H}] > \mathbf{Cu} > \text{Hg} > \text{Ag} > \text{Au}$$

Since zinc (Zn) is positioned higher than copper (Cu) in the activity series, zinc is more reactive than copper. It oxidizes more readily, transferring electrons to copper ions in solution:

$$\text{Zn(s)} + \text{CuSO}_4\text{(aq)} \rightarrow \text{ZnSO}_4\text{(aq)} + \text{Cu(s)}$$



Therefore, Zinc displaces Copper because Zinc is more reactive.

Final Answer: Zn is more reactive

Answer: (B)

Go Back to Question 8

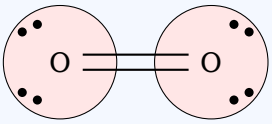
Q9.

Solution

Concept: Covalent bonds are formed when atoms share valence electrons to achieve a stable octet (8 valence electrons) configuration, resembling the nearest noble gas.

Solution: An oxygen atom (O, atomic number 8) has 6 valence electrons (electronic configuration: $2, 6$). To complete its valence shell and attain a stable octet configuration, each oxygen atom requires 2 more electrons.
When two oxygen atoms combine to form an O_2 molecule, each atom contributes 2 electrons for sharing. This results in the sharing of two pairs of electrons (a total of 4 shared electrons) between the two atoms, establishing a double covalent bond:

$$:\ddot{O}::\ddot{O}: \quad \text{or} \quad O = O$$



Thus, the bond in an O_2 molecule is a double bond.

Final Answer: Double bond

Answer: (B)

Go Back to Question 9

Q10.

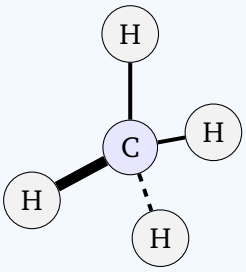
Solution

Concept: The shape of a molecule is determined by the Valence Shell Electron Pair Repulsion (VSEPR) theory. According to VSEPR theory, electron pairs (both bonding and lone pairs) surrounding a central atom orient themselves in space to minimize electrostatic repulsion.

Solution: In a methane (CH_4) molecule:

- The central carbon atom has 4 valence electrons.
- It forms 4 single covalent bonds with 4 hydrogen atoms.
- There are 4 bonding pairs and 0 lone pairs around the carbon atom (steric number = 4).

An arrangement with 4 electron pairs experiencing minimum repulsion is one where they point towards the vertices of a regular tetrahedron. This geometry is tetrahedral, with a characteristic bond angle of $109.5°$.



Thus, the geometry of methane is tetrahedral.

Final Answer: Tetrahedral

Answer: (C)

Go Back to Question 10

Q11.

Solution

Concept: Quantum numbers are used to completely describe the position, energy, orientation, and spin of an electron in an atom. There are four quantum numbers:

(a) **Principal quantum number (n):** Determines the shell, size, and major energy level of the orbital.

(b) **Azimuthal (angular momentum) quantum number (l):** Determines the subshell and the shape of the orbital.

(c) **Magnetic quantum number (m_l):** Determines the spatial orientation of the orbital in space.

(d) **Spin quantum number (s):** Describes the spin orientation of the electron.

Solution: The azimuthal quantum number l can take integer values from 0 to $n-1$. Each value of l corresponds to a specific orbital shape:

- $l = 0$: s orbital (spherical shape)
- $l = 1$: p orbital (dumbbell shape)
- $l = 2$: d orbital (double-dumbbell or cloverleaf shape)
- $l = 3$: f orbital (complex shape)

s ($l = 0$) p ($l = 1$)

Therefore, the azimuthal quantum number defines the shape of the orbital.

Final Answer: Azimuthal quantum number

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept: Isotopes are variants of a particular chemical element. By definition:

- They share the same atomic number (Z), which means they have the same number of protons and electrons, and thus identical chemical properties.
- They have different mass numbers (A), which means they have a different total number of nucleons (protons + neutrons) in their nuclei.

Solution: The relationship between mass number (A), proton number (Z), and neutron number (N) is:

$$A = Z + N \implies N = A - Z$$

Since Z is identical for all isotopes of a given element but A is different, the isotopes must differ in their number of neutrons (N). For example, hydrogen has three isotopes:

- Protium (^{1}H): 1 proton, 0 neutrons
- Deuterium (^{2}H): 1 proton, 1 neutron
- Tritium (^{3}H): 1 proton, 2 neutrons

Protium (^{1}H) Deuterium (^{2}H)

Therefore, isotopes differ in their number of neutrons.

Final Answer: Number of neutrons

Answer: (C)

Go Back to Question 12

Q13.

Solution

Concept: A chemical equation represents a chemical reaction using chemical formulas. Balancing a chemical equation ensures that the number of atoms of each element is the same on both the reactant and the product side.

Solution: The fundamental principle underlying the balancing of chemical equations is the Law of Conservation of Mass (formulated by Antoine Lavoisier in 1789). This law states that:

Mass can neither be created nor destroyed in a chemical reaction.

Since mass is conserved, the total mass of the reactants must equal the total mass of the products. At the atomic level, this means that every atom present in the starting materials must be present in the products (atoms are only rearranged, not created or destroyed).

Mass of Reactants = Mass of Products

Hence, a balanced chemical equation follows the Law of Conservation of Mass.

Final Answer: Conservation of mass

Answer: (A)

Go Back to Question 13

Q14.

Solution

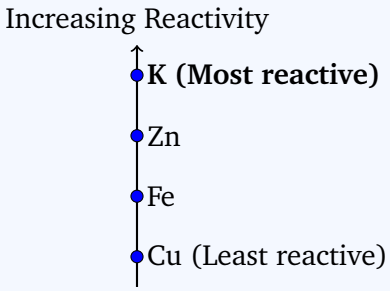
Concept: The reactivity of a metal is determined by its tendency to lose electrons and form positive ions (cations). In the metal activity series, metals are arranged in decreasing order of their chemical reactivity.

Solution: Comparing the positions of the given metals in the reactivity series:

$$\mathbf{K} > \text{Na} > \text{Ca} > \text{Mg} > \text{Al} > \mathbf{Zn} > \mathbf{Fe} > \text{Pb} > [\text{H}] > \mathbf{Cu} > \text{Hg} > \text{Ag} > \text{Au}$$

- **Potassium (K):** Group 1 alkali metal. It has a single valence electron and very low ionization energy, making it highly electropositive and extremely reactive.
- **Zinc (Zn) & Iron (Fe):** Moderately reactive transition metals.
- **Copper (Cu):** Low-reactivity transition metal located below hydrogen in the reactivity series.

Since potassium (K) is located at the top among the given choices, it is the most reactive metal.



Therefore, the correct option is C.

Final Answer: K

Answer: (C)

Go Back to Question 14

Q15.

Solution

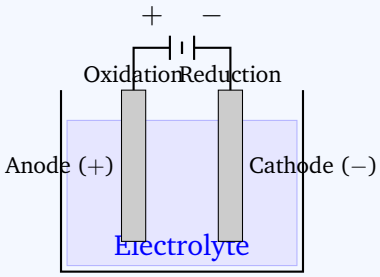
Concept: During electrolysis, electrical energy is used to drive a non-spontaneous chemical reaction. The processes of oxidation and reduction are defined as follows:

- **Oxidation:** The loss of electrons.
- **Reduction:** The gain of electrons.

Solution: In an electrochemical or electrolytic cell:

- **Anode:** The electrode where oxidation occurs. Anions in the electrolyte migrate to the anode to lose electrons.
- **Cathode:** The electrode where reduction occurs. Cations migrate to the cathode to gain electrons.

A common mnemonic to remember this is "AN OX" (Anode Oxidation) and "RED CAT" (Reduction Cathode).



Therefore, oxidation always occurs at the anode during electrolysis, which corresponds to option B.

Final Answer: Anode

Answer: (B)

Go Back to Question 15

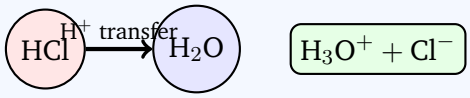
Q16.

Solution

Concept: Strong acids (like HCl, HNO_3, and H_2SO_4) are molecular substances that undergo ionization when dissolved in a solvent. The degree of ionization depends heavily on the properties of the solvent.

Solution: Water (H_2O) is a highly polar solvent with a high dielectric constant (≈ 80). When a strong acid like hydrochloric acid (HCl) is dissolved in water, the polar water molecules surround the acid molecules, hydrate the resulting ions, and completely break the polar covalent bond. This causes complete ionization into hydronium (H_3O^+) and chloride (Cl^-) ions:

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



In non-polar solvents like benzene (C_6H_6), poorly polar solvents like alcohol, or in the solid state, strong acids do not completely ionize due to the lack of sufficient electrostatic stabilization for the generated ions. Thus, the correct option is A.

Final Answer: Water

Answer: (A)

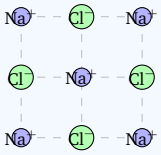
Go Back to Question 16

Q17.

Solution

Concept: Common salt (or table salt) is an essential dietary mineral and ionic compound. It consists of equal proportions of sodium and chlorine.

Solution: The chemical name for common salt is Sodium Chloride, which has the empirical formula NaCl. It exists as a crystalline solid formed by a regular three-dimensional ionic lattice of sodium cations (Na^+) and chloride anions (Cl^-).



Other choices:

- NaOH is sodium hydroxide (caustic soda).
- KCl is potassium chloride.
- $CaCO_3$ is calcium carbonate (limestone).

Thus, the correct option is B.

Final Answer: NaCl

Answer: (B)

Go Back to Question 17

Q18.

Solution

Concept: Rusting is the corrosion of iron (Fe). It is an electrochemical redox process in which iron is oxidized to hydrated iron(III) oxide ($Fe_2O_3 \cdot xH_2O$).

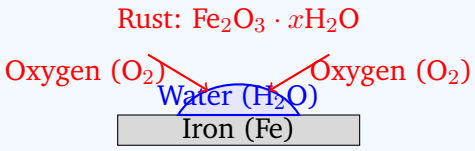
Solution: For rusting to occur, both of the following environmental factors must be simultaneously present:

(a) **Oxygen (O_2):** Acts as the oxidizing agent.

(b) **Water (H_2O/Moisture):** Acts as the medium (electrolyte) for the migration of ions and completion of the electrochemical cell.

$$4Fe(s) + 3O_2(g) + 2xH_2O(l) \rightarrow 2Fe_2O_3 \cdot xH_2O(s) \quad \text{(Rust)}$$

In the absence of either dry air (oxygen) or moisture (water), iron will not rust.



Therefore, rusting of iron requires both oxygen and water, which corresponds to option C.

Final Answer: Oxygen and water

Answer: (C)

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Q19.

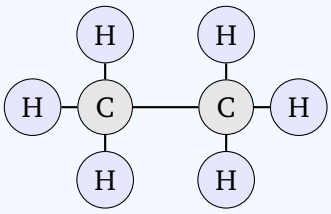
Solution

Concept: Hydrocarbons are the simplest class of organic compounds. As the name implies, they are composed exclusively of two elements.

Solution: The name "hydrocarbon" is a combination of *hydrogen* and *carbon*. Thus, hydrocarbons contain only:

- Carbon (C)
- Hydrogen (H)

They can be categorized into alkanes, alkenes, alkynes, and aromatic hydrocarbons. A classic example is ethane (C_2H_6):



Therefore, hydrocarbons contain carbon and hydrogen, which corresponds to option A.

Final Answer: Carbon and hydrogen

Answer: (A)

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Q20.

Solution

Concept: Combustion is a high-temperature exothermic chemical reaction between a fuel and an oxidant. The products formed depend on the availability of oxygen.

Solution: When a hydrocarbon fuel undergoes complete combustion in the presence of excess oxygen (O_2), the carbon is fully oxidized to carbon dioxide (CO_2) and the hydrogen is fully oxidized to water (H_2O):

$$\text{Hydrocarbon} + O_2 \text{ (excess)} \rightarrow CO_2 + H_2O + \text{Heat}$$

$$\boxed{\text{Fuel} + O_2 \text{ (excess)}} \longrightarrow \boxed{CO_2 + H_2O + \text{Heat}}$$

Complete Combustion

If oxygen is limited (incomplete combustion), carbon monoxide (CO) or soot (carbon, C) is produced instead. Thus, complete combustion produces CO_2 and H_2O, which corresponds to option B.

Final Answer: $\boxed{CO_2 \text{ and } H_2O}$

Answer: (B)

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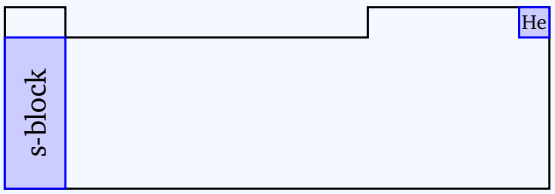
Q21.

Solution

Concept: The periodic table is divided into four blocks (s, p, d, f) based on the subshell into which the outermost valence electron enters.

Solution:

- **s-block elements:** Elements where the last electron enters the outermost s-orbital. This block consists of Group 1 (alkali metals) and Group 2 (alkaline earth metals) along with helium.
- **p-block elements:** Groups 13 to 18.
- **d-block elements:** Groups 3 to 12 (transition metals).
- **f-block elements:** Lanthanides and Actinides (inner transition metals).



Therefore, the s-block elements are found in Group 1 and Group 2, which corresponds to option A.

Final Answer: Group 1 and 2

Answer: (A)

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Q22.

Solution

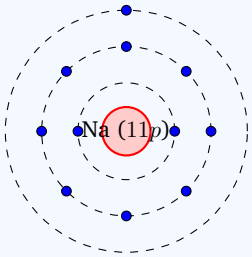
Concept: In the Bohr model of the atom, electrons are distributed in shell levels designated as K, L, M, N, etc. The maximum capacity of each shell is given by the formula $2n^2$, where n is the shell number.

- K shell ($n = 1$): Maximum 2 electrons
- L shell ($n = 2$): Maximum 8 electrons
- M shell ($n = 3$): Maximum 18 electrons

Solution: Sodium (Na) has an atomic number of 11, meaning a neutral sodium atom has 11 protons and 11 electrons. The distribution of these 11 electrons starting from the innermost shell is:

- **K shell:** 2 electrons (completely filled)
- **L shell:** 8 electrons (completely filled)
- **M shell:** 1 electron (remaining)

This gives an electronic configuration of 2, 8, 1.



Shells: 2, 8, 1

Therefore, the correct option is A.

Final Answer: 2,8,1

Answer: (A)

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Q23.

Solution

Concept: Isotopes are defined as atoms of the same chemical element (meaning they have the same number of protons and the same atomic number) that have different mass numbers (different number of neutrons).

Solution: Let us evaluate the choices:

(A) **C-12 and C-14:** Both are isotopes of carbon. They have the same atomic number ($Z = 6$), but different mass numbers ($A = 12$ and $A = 14$) because Carbon-12 has 6 neutrons and Carbon-14 has 8 neutrons.

(B) **Na and K:** Different elements (Group 1 alkali metals, Sodium and Potassium).

(C) **H and He:** Different elements (Hydrogen and Helium).

(D) **O and N:** Different elements (Oxygen and Nitrogen).

Same proton number (6), different neutron number (6 vs 8)

Therefore, C-12 and C-14 are isotopes, which corresponds to option A.

Final Answer: C-12 and C-14

Answer: (A)

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Q24.

Solution

Concept: Chemical equations represent chemical changes where reactant substances turn into product substances. A balanced chemical equation must have equal numbers of atoms of each element on both sides of the reaction arrow.

Solution: Balancing chemical equations is based on the Law of Conservation of Mass. Formulated by Antoine Lavoisier, it states that mass is neither created nor destroyed in a chemical reaction.

Since mass must remain constant, the number of atoms of each element on the reactant side must equal the number of atoms of those same elements on the product side. For example, in the formation of water:

$$\text{Reactants: } 2H_2 + O_2 \quad \longrightarrow \quad \text{Products: } 2H_2O$$

$$\boxed{2H_2 + O_2} \xrightarrow{\text{Balanced}} \boxed{2H_2O}$$

4 H atoms, 2 O atoms — 4 H atoms, 2 O atoms

Thus, balancing is a direct application of the Law of Conservation of Mass, which corresponds to option B.

Final Answer: Law of conservation of mass

Answer: (B)

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Q25.

Solution

Concept: Industrial processes are optimized chemical procedures designed to produce commercial chemicals in large quantities.

Solution: The Haber process (also known as the Haber-Bosch process) is the primary industrial method for synthesizing Ammonia (NH_3) from atmospheric nitrogen (N_2) and hydrogen (H_2) gas. It uses an iron catalyst under high pressure (150–250 atm) and temperature (400–450°C):

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92.4 \text{ kJ/mol}$$

$$\boxed{N_2(g) + 3H_2(g)} \xrightarrow[\text{High } P,T]{\text{Fe Catalyst}} \boxed{2NH_3(g)}$$

Other options:

- Sulfuric acid is manufactured via the Contact process.
- Nitric acid is manufactured via the Ostwald process.

Therefore, the Haber process is used for the production of ammonia, which corresponds to option B.

Final Answer: Ammonia

Answer: (B)

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	B	3	C	4	B	5	B
6	C	7	A	8	B	9	B	10	C
11	B	12	C	13	A	14	C	15	B
16	A	17	B	18	C	19	A	20	B
21	A	22	A	23	A	24	B	25	B