

JEECUP Group A Chemistry Sample Paper – 17

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. An electron is projected perpendicular to a uniform magnetic field. It follows a circular path. If the velocity of the electron is doubled, what happens to the radius of the path?

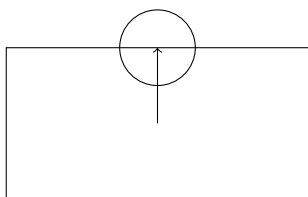
- (A) Becomes half
- (B) Becomes double
- (C) Becomes four times
- (D) Remains unchanged

Q2. Two elements A and B lie in the same group of the periodic table. A is above B. Which statement correctly compares their electronegativity?

- (A) A has lower electronegativity than B
- (B) B has lower electronegativity than A
- (C) Both have equal electronegativity
- (D) Cannot be predicted



Q3. A gas is collected over water as shown in the diagram. The gas is highly soluble in water and forms an acidic solution.



- (A) NH_3
- (B) HCl
- (C) O_2
- (D) H_2

Q4. Which of the following reactions represents a redox reaction?

- (A) $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
- (B) $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$
- (C) $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$
- (D) $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$

Q5. Atomic radius decreases across a period due to increase in:

- (A) Atomic mass
- (B) Nuclear charge
- (C) Shielding effect
- (D) Number of shells

Q6. A metal reacts vigorously with water producing hydrogen gas and a strong base. The metal is most likely:

- (A) Fe
- (B) Cu
- (C) Na
- (D) Ag



- Q7.** In electrolysis of molten NaCl, chlorine gas is released at:
- (A) Cathode
 - (B) Anode
 - (C) Electrolyte
 - (D) Salt bridge
- Q8.** Which compound is most likely to show covalent bonding?
- (A) NaCl
 - (B) MgO
 - (C) H₂O
 - (D) KBr
- Q9.** A solution turns red litmus paper blue. The pH of the solution is likely:
- (A) 2
 - (B) 5
 - (C) 7
 - (D) 12
- Q10.** Which property increases across a period in the periodic table?
- (A) Atomic radius
 - (B) Metallic character
 - (C) Electronegativity
 - (D) Basic nature of oxides
- Q11.** A compound has low melting point and does not conduct electricity in solid state. It is most likely:
- (A) Ionic compound
 - (B) Metallic compound



- (C) Covalent compound
- (D) Salt

Q12. Which process is used to separate crude oil into fractions?

- (A) Filtration
- (B) Distillation
- (C) Chromatography
- (D) Sublimation

Q13. The correct electronic configuration of chlorine ($Z = 17$) is:

- (A) 2,8,7
- (B) 2,7,8
- (C) 2,8,6
- (D) 2,6,7

Q14. Which of the following is an example of a combination reaction?

- (A) $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$
- (B) $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$
- (C) $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
- (D) $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$

Q15. Rusting of iron requires both oxygen and water. This is an example of:

- (A) Physical change
- (B) Chemical change
- (C) Nuclear change
- (D) Reversible change



- Q16.** Which gas is most suitable for filling balloons due to being light and non-reactive?
- (A) Oxygen
(B) Hydrogen
(C) Nitrogen
(D) Chlorine
- Q17.** Valency of an element is determined by:
- (A) Neutrons in nucleus
(B) Outer shell electrons
(C) Atomic mass
(D) Number of shells
- Q18.** Which of the following is a strong electrolyte?
- (A) Glucose solution
(B) Alcohol solution
(C) NaCl solution
(D) Urea solution
- Q19.** Which reaction is an example of displacement reaction?
- (A) $\text{HCl} + \text{NaOH}$
(B) $\text{Zn} + \text{CuSO}_4$
(C) CaCO_3 decomposition
(D) $\text{H}_2 + \text{Cl}_2$
- Q20.** The Haber process is used for industrial production of:
- (A) Oxygen
(B) Ammonia



- (C) Nitrogen
- (D) Carbon dioxide

Q21. A student observes that when a strip of metal X is placed in a solution of salt of metal Y, metal Y gets deposited on X. This indicates that:

- (A) X is less reactive than Y
- (B) X is more reactive than Y
- (C) Both have equal reactivity
- (D) No reaction occurs

Q22. In the following representation of electron transfer, metal A loses electrons to metal B forming an ionic compound. This process mainly involves:



- (A) Sharing of electrons
- (B) Transfer of electrons
- (C) Sharing of protons
- (D) Transfer of neutrons

Q23. A compound shows high melting point, conducts electricity in molten state, and is soluble in water. The bonding present is most likely:

- (A) Covalent bonding
- (B) Ionic bonding
- (C) Metallic bonding
- (D) Hydrogen bonding

Q24. During a chemical reaction, the total mass of reactants remains equal to the total mass of products. This observation is based on which law?

- (A) Law of definite proportions



- (B) Law of conservation of mass
- (C) Law of multiple proportions
- (D) Avogadro's law

Q25. Which fuel produces maximum environmental pollution when burnt due to high carbon content and impurities?

- (A) LPG
- (B) CNG
- (C) Coal
- (D) Hydrogen



Detailed Solutions

Q1.

Solution

Concept: A charged particle entering a uniform magnetic field \vec{B} with $\vec{v} \perp \vec{B}$ experiences Lorentz force:

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

Since this force is always perpendicular to velocity, it does no work. Speed remains constant, only direction changes. Thus, magnetic force acts as centripetal force:

$$F_c = F_B$$

Hence, the particle moves in a circular path.

We equate magnetic and centripetal forces:

$$\frac{mv^2}{r} = |q|vB \sin 90^\circ$$

Since $\sin 90^\circ = 1$:

$$\frac{mv^2}{r} = |q|vB$$

Thus,

$$r = \frac{mv}{|q|B}$$

Solution: Step 1: Radius of circular path For an electron moving perpendicular to a uniform magnetic field,

$$r_1 = \frac{mv}{eB}$$

Step 2: New velocity If the velocity is doubled, $v_2 = 2v$. Then,

$$r_2 = \frac{mv_2}{eB} = \frac{m(2v)}{eB}$$

Step 3: Ratio of radii

$$\frac{r_2}{r_1} = \frac{\frac{2mv}{eB}}{\frac{mv}{eB}} = 2 \Rightarrow r_2 = 2r_1$$

Final Answer:

Answer: (B)

[Go Back to Question 1](#)



Q2.

Solution

Concept: Electronegativity is the tendency of an atom to attract shared electrons in a covalent bond. Down a group, electronegativity decreases due to:

- (a) Increase in atomic size, increasing distance of valence electrons from nucleus.
- (b) Increase in shielding effect from inner shells, reducing nuclear attraction.

Thus, effective nuclear attraction decreases, lowering electronegativity down the group.

Solution: Step 1: Set up the spatial arrangement. We are given that elements A and B belong to the same group of the periodic table, and element A is located directly above element B:



Step 2: Apply the vertical periodic trend. Since electronegativity decreases down a group, the element positioned higher up in the group (element A) will have a stronger pull on bonding electrons than the element located lower down (element B):

$$\text{Electronegativity of A} > \text{Electronegativity of B}$$

Step 3: Analyze the relationship. We can rewrite this inequality in two equivalent ways:

- A has a higher electronegativity than B.
- B has a lower electronegativity than A.

Step 4: Match with the given options.

- **Option A (A has lower electronegativity than B):** Incorrect, because A is higher in the group and must have a higher electronegativity.
- **Option B (B has lower electronegativity than A):** Correct, as it matches the inequality $\text{Electronegativity of B} < \text{Electronegativity of A}$.
- **Option C (Both have equal electronegativity):** Incorrect, as different elements in the same group have distinct numbers of electron shells and different nuclear charges, meaning their electronegativities cannot be identical.
- **Option D (Cannot be predicted):** Incorrect, as the vertical electronegativity trend is highly consistent across groups in the s- and p-blocks.

Final Answer: B has lower electronegativity than A

Answer: (B)

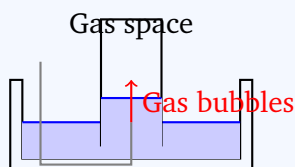
[Go Back to Question 2](#)



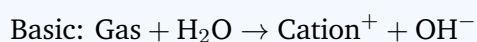
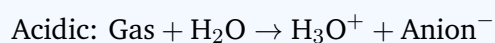
Q3.

Solution

Concept: Gases are collected over water only if they are insoluble or sparingly soluble in water. If a gas is soluble or reacts with water, it cannot be collected by this method, as it dissolves instead of being displaced into the gas jar.



When a highly soluble gas dissolves in water, it may also react to form acidic or basic solutions:

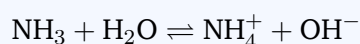


Solution: Step 1: Solubility behavior

- O_2 and H_2 are non-polar diatomic gases with very weak interaction with polar water molecules, so they are only sparingly soluble and can be collected over water.
- NH_3 and HCl are polar gases and show strong interaction with water, making them highly soluble.

Step 2: Behaviour in water

- NH_3 reacts reversibly with water to form ammonium and hydroxide ions:



This produces a basic solution due to OH^- ions.

- HCl completely ionizes in water to form hydronium and chloride ions:



This results in a strongly acidic solution.

Step 3: Conclusion A gas that is highly soluble in water and forms an acidic solution must be HCl , since it produces H_3O^+ ions in water.

Final Answer:

Answer: (B)

[Go Back to Question 3](#)



Q4.

Solution

Concept: A redox reaction involves transfer of electrons between species, identified using oxidation states.

- **Oxidation:** Increase in oxidation state (loss of electrons).
- **Reduction:** Decrease in oxidation state (gain of electrons).

If no oxidation state changes occur, the reaction is not a redox reaction.

Solution:

We check oxidation state changes in each option.

Option A: $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

- All oxidation states remain unchanged: H(+1), Cl(-1), Na(+1), O(-2)

No redox change (neutralization reaction).

Option B: $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$

- $\text{Zn}^0 \rightarrow \text{Zn}^{2+}$ (oxidation)
- $\text{Cu}^{2+} \rightarrow \text{Cu}^0$ (reduction)

Redox reaction occurs.

Option C: $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$

- No change in oxidation states

Precipitation (not redox).

Option D: $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$

- Oxidation states remain unchanged

Thermal decomposition (not redox).

Final Answer: $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$

Answer: (B)

[Go Back to Question 4](#)



Q5.

Solution

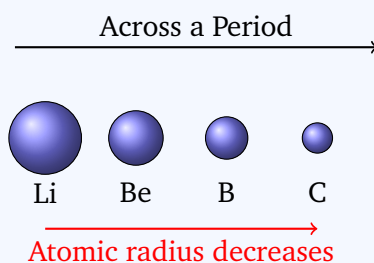
Concept: Atomic radius is the distance from the nucleus to the outermost electron shell. Across a period, electrons are added to the same shell while nuclear charge increases. Hence attraction increases. By Coulomb's law:

$$F_e = k_e \frac{q_1 q_2}{r^2}$$

Effective nuclear charge:

$$Z_{\text{eff}} = Z - S$$

Since Z increases significantly while shielding S changes little, Z_{eff} increases across a period, pulling electrons closer and decreasing atomic radius.



Solution: Option A (Atomic mass): Atomic mass increases with atomic number, but it does not affect the size of the electron cloud, so it is not responsible for atomic radius decrease.

Option B (Nuclear charge): Across a period, nuclear charge (Z) increases while shielding remains nearly constant. This increases attraction on valence electrons, reducing atomic radius. **This is the correct reason.**

Option C (Shielding effect): Shielding remains almost unchanged across a period because electrons are added to the same shell, so it does not cause the decrease in size.

Option D (Number of shells): The number of shells remains constant across a period, so it does not explain the decrease in atomic radius.

Final Answer:

Answer: (B)

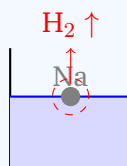
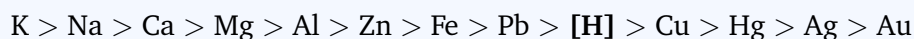
[Go Back to Question 5](#)



Q6.

Solution

Concept: The reactivity of metals with water is a measure of their electropositive character (their tendency to lose electrons to form positive ions). This reactivity is summarized in the metal reactivity series:



Highly reactive metals (like alkali metals in Group 1) have low ionization energies and react vigorously with cold water. Metals of moderate reactivity react only with hot water or steam, while low-reactivity metals situated below hydrogen do not react at all.

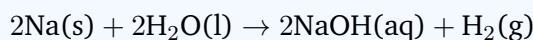
Solution: Let us evaluate the reaction of each given metal with water: **Step 1: Analyze Iron (Fe).** Iron is a transition metal with moderate reactivity. It does not react with cold or hot water. It only reacts when red-hot with steam to produce iron(II,III) oxide and hydrogen gas:



This is not a vigorous reaction with liquid water and does not form a strong base (alkali).

Step 2: Analyze Copper (Cu) and Silver (Ag). Copper and silver are transition metals positioned below hydrogen in the reactivity series. They do not react with water or steam under any conditions.

Step 3: Analyze Sodium (Na). Sodium is an alkali metal (Group 1) with a single valence electron that it loses very easily. It reacts vigorously, often violently, with cold water. The reaction is highly exothermic, producing a colorless solution of sodium hydroxide and hydrogen gas:



Sodium hydroxide (NaOH) is a strong, highly soluble base (alkali). This perfectly matches the criteria given in the question.

Final Answer:

Answer: (C)

[Go Back to Question 6](#)



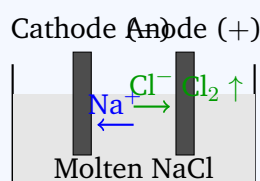
Q7.

Solution

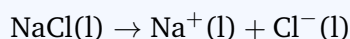
Concept: During the electrolysis of molten salts, there is no water present, so we do not have to consider competing reactions from the oxidation or reduction of water.

An electrolytic cell contains two electrodes connected to a direct current (DC) power source:

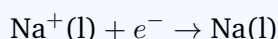
- **Cathode:** Connected to the negative terminal of the power supply. Cations (positive ions) migrate to the cathode to undergo reduction (gain of electrons).
- **Anode:** Connected to the positive terminal of the power supply. Anions (negative ions) migrate to the anode to undergo oxidation (loss of electrons).



Solution: Step 1: Identify the ions present in molten NaCl. Molten sodium chloride contains only free-moving sodium cations and chloride anions:



Step 2: Determine the reaction at the cathode (negative electrode). The positive sodium ions (Na^+) migrate toward the negative electrode (cathode), where they gain electrons (reduction) to form liquid sodium metal:



Step 3: Determine the reaction at the anode (positive electrode). The negative chloride ions (Cl^-) migrate toward the positive electrode (anode), where they lose electrons (oxidation) to form chlorine gas molecules (Cl_2):



Step 4: Conclude which gas is released and where. Chlorine gas is oxidized and liberated at the anode (Option B), while sodium metal is reduced and deposited at the cathode (Option A).

Final Answer:

Answer: (B)

[Go Back to Question 7](#)

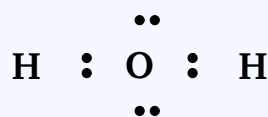


Q8.

Solution

Concept: The type of chemical bond that forms between two atoms is primarily determined by the difference in their electronegativities ($\Delta\chi$):

- **Ionic Bond** ($\Delta\chi \gtrsim 1.7$ to 2.0): Formed when a metal (highly electropositive) transfers one or more electrons to a non-metal (highly electronegative). This creates oppositely charged ions held together by strong electrostatic forces.
- **Covalent Bond** ($\Delta\chi < 1.7$): Formed when two non-metals share one or more pairs of electrons to achieve a stable octet (or duplet) configuration.



Solution: Let us analyze the chemical constituents of each option:

Step 1: Evaluate NaCl (Sodium chloride). Sodium (Na) is an alkali metal (Group 1) and chlorine (Cl) is a halogen (Group 17, non-metal). The electronegativity difference is very large:

$$\Delta\chi = 3.16 (\text{Cl}) - 0.93 (\text{Na}) = 2.23 > 1.7$$

This compound is ionic.

Step 2: Evaluate MgO (Magnesium oxide). Magnesium (Mg) is an alkaline earth metal (Group 2) and oxygen (O) is a non-metal (Group 16). The electronegativity difference is:

$$\Delta\chi = 3.44 (\text{O}) - 1.31 (\text{Mg}) = 2.13 > 1.7$$

This compound is ionic.

Step 3: Evaluate KBr (Potassium bromide). Potassium (K) is an alkali metal (Group 1) and bromine (Br) is a halogen (Group 17, non-metal). The electronegativity difference is:

$$\Delta\chi = 2.96 (\text{Br}) - 0.82 (\text{K}) = 2.14 > 1.7$$

This compound is ionic.

Step 4: Evaluate H₂O (Water). Both hydrogen (H) and oxygen (O) are non-metals. The electronegativity difference is:

$$\Delta\chi = 3.44 (\text{O}) - 2.20 (\text{H}) = 1.24 < 1.7$$

Since both are non-metals and the difference is below 1.7, they share valence electrons to form polar covalent bonds.

Final Answer: H₂O

Answer: (C)

[Go Back to Question 8](#)



Q9.

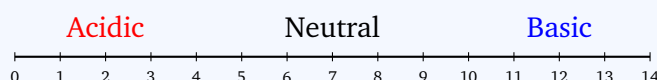
Solution

Concept: pH measures hydrogen ion concentration:

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

Litmus is a natural pH indicator that changes color based on acidity/basicity:

- **Acidic (pH < 7):** High H^+ concentration \rightarrow litmus turns red.
- **Neutral (pH = 7):** No change \rightarrow litmus remains purple.
- **Basic (pH > 7):** High OH^- concentration \rightarrow litmus turns blue.



Solution: Step 1: Determine the nature of the solution. The problem states that the given solution turns red litmus paper blue. According to the properties of indicators, this behavior chemically identifies the solution as basic (alkaline).

Step 2: Relate the chemical nature to a pH value. Basic solutions must have a pH value greater than 7 on the standard scale at 25°C :

$$\text{pH}_{\text{solution}} > 7$$

Step 3: Analyze each of the given options.

- **Option A (pH = 2):** This is a strongly acidic solution. It would turn blue litmus paper red.
- **Option B (pH = 5):** This is a weakly acidic solution. It would turn blue litmus paper red.
- **Option C (pH = 7):** This is a neutral solution. It would not change the color of red litmus paper.
- **Option D (pH = 12):** This is a strongly basic solution. It successfully turns red litmus paper blue.

Step 4: Conclude the correct value. The only value in the options that represents a basic solution is 12.

Final Answer:

Answer: (D)

[Go Back to Question 9](#)



Q10.

Solution

Concept: As we move from left to right across a period in the periodic table, several properties change in a predictable manner due to the steady increase in atomic number (protons in the nucleus) while the electrons are added to the same main energy shell. This increases the effective nuclear charge (Z_{eff}), drawing the electron cloud tighter.

Electronegativity increases



Atomic radius decreases

Solution: Let us analyze each given property to see if it increases across a period:

Step 1: Analyze Option A (Atomic radius). Because the effective nuclear charge increases and pulls the valence shell closer, the atomic radius **decreases** across a period.

Step 2: Analyze Option B (Metallic character). Metallic character refers to an element's ability to lose electrons easily. Across a period, as the nuclear pull increases, it becomes progressively harder for atoms to lose electrons. Thus, metallic character **decreases** (and non-metallic character increases).

Step 3: Analyze Option C (Electronegativity). Electronegativity is the ability of an atom to attract shared electrons in a bond. Since the effective nuclear charge increases and the atomic radius decreases, the nucleus can exert a much stronger attractive force on external electrons. Therefore, electronegativity **increases** across a period.

Step 4: Analyze Option D (Basic nature of oxides). Elements on the left side of a period are metals, which form basic oxides (e.g., Na_2O). Elements on the right side are non-metals, which form acidic oxides (e.g., SO_3). Consequently, the basic nature of oxides **decreases** across a period.

Final Answer:

Answer: (C)

[Go Back to Question 10](#)

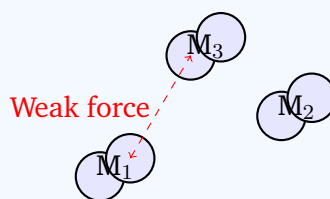


Q11.

Solution

Concept: Macroscopic properties depend on bonding type:

- **Ionic solids:** Strong electrostatic lattice of ions → high melting point. Conduct only when molten or in solution due to mobile ions.
- **Metals:** Lattice of positive ions with delocalized electrons → good electrical conductivity in solid state.
- **Covalent (molecular):** Discrete molecules with weak intermolecular forces → low melting point and no electrical conductivity.



Solution: Step 1: Match the property of low melting point. A low melting point indicates that the forces holding the lattice units together are relatively weak. This rules out ionic compounds, salts, and metallic compounds, which are dominated by strong electrostatic or metallic bonds. Instead, it points to molecular covalent compounds, which are held together by weak intermolecular forces.

Step 2: Match the property of electrical conductivity. The substance does not conduct electricity in the solid state. Since it also has a low melting point, it must be composed of neutral molecules rather than ions or free electrons.

Step 3: Evaluate each option.

- **Ionic compound / Salt (Options A & D):** Have high melting points due to strong ionic lattices.
- **Metallic compound (Option B):** Conducts electricity in the solid state and typically has a high melting point.
- **Covalent compound (Option C):** Typically has a low melting point and does not conduct electricity because it contains no charged carriers.

Therefore, the compound described is most likely a covalent compound.

Final Answer:

Answer: (C)

[Go Back to Question 11](#)



Q12.

Solution

Concept: Crude oil is a mixture of hydrocarbons with different chain lengths and boiling points.

- Short-chain hydrocarbons have weaker intermolecular forces → low boiling points.
- Long-chain hydrocarbons have stronger intermolecular forces → high boiling points.

Separation is done using a fractionating column with a temperature gradient, producing useful fractions like LPG, petrol, kerosene, and diesel.

Solution: Let us evaluate each separation technique:

Step 1: Evaluate Option A (Filtration). Filtration is a mechanical separation process used to separate solid particles from a liquid or gas by passing the mixture through a porous medium. It cannot separate miscible liquids like the hydrocarbons in crude oil.

Step 2: Evaluate Option B (Distillation). Distillation, specifically **fractional distillation**, is used to separate miscible liquids with different boiling points. Crude oil is heated in a furnace and the vaporized mixture is sent into a fractionating column. The column is hot at the bottom and cooler at the top. As the vapors rise, different hydrocarbons condense back into liquids at the levels corresponding to their specific boiling points, allowing them to be drawn off separately. This is the correct process.

Step 3: Evaluate Option C (Chromatography). Chromatography is a laboratory technique used to separate and analyze small quantities of mixtures based on how different components distribute themselves between a stationary phase and a mobile phase. It is not viable for large-scale industrial processing of crude oil.

Step 4: Evaluate Option D (Sublimation). Sublimation is the transition of a substance directly from the solid to the gas phase without passing through the liquid phase. It is used to separate a sublimable solid (like iodine or ammonium chloride) from non-sublimable solids. It is not applicable to a liquid mixture like crude oil.

Final Answer:

Answer: (B)

[Go Back to Question 12](#)

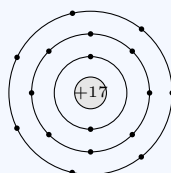


Q13.

Solution

Concept: Electronic configuration describes the distribution of electrons in an atom's shells.

- Electrons fill shells in order of increasing energy, starting from the K-shell.
- Maximum electrons in shell n is given by $2n^2$:
 - K-shell ($n = 1$): 2 electrons
 - L-shell ($n = 2$): 8 electrons
 - M-shell ($n = 3$): 18 electrons
- A new shell starts filling only after inner shells are filled.



Chlorine (2,8,7)

Solution: Step 1: Total electrons Chlorine has atomic number $Z = 17$, so it has 17 electrons.

Step 2: Shell-wise distribution

- K-shell: 2 electrons \rightarrow remaining 15
- L-shell: 8 electrons \rightarrow remaining 7
- M-shell: remaining 7 electrons

Step 3: Electronic configuration

Configuration = 2, 8, 7

Step 4: Option check

- A (2,8,7): Correct
- B (2,7,8): Incorrect (L-shell not filled first)
- C (2,8,6): Incorrect (only 16 electrons)
- D (2,6,7): Incorrect (incorrect distribution)

Final Answer: 2,8,7

Answer: (A)

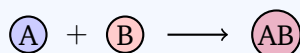
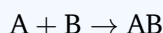
[Go Back to Question 13](#)



Q14.

Solution

Concept: A **combination reaction** (also known as a synthesis reaction) is a fundamental class of chemical reactions in which two or more simple substances (reactants) chemically bond to form a single, more complex substance (product). The general chemical equation representing a combination reaction is:



These reactions are usually exothermic because bond formation releases energy to the surroundings.

Solution: Let us systematically analyze each of the chemical equations presented in the options:

Step 1: Analyze Option A: $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$ In this reaction, calcium oxide (quicklime, CaO) reacts with water (H₂O) to form a single product, calcium hydroxide (slaked lime, Ca(OH)₂). Since two distinct reactants combine to yield a single product, this represents a combination reaction.

Step 2: Analyze Option B: $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$ Here, elemental zinc (Zn) displaces copper (Cu) from copper(II) sulfate (CuSO₄). Since one element replaces another in a compound, this is a **single displacement reaction**.

Step 3: Analyze Option C: $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ In this process, a single reactant (calcium carbonate, CaCO₃) breaks down under heating to produce two simpler substances: calcium oxide (CaO) and carbon dioxide (CO₂). This represents a **thermal decomposition reaction**.

Step 4: Analyze Option D: $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$ In this reaction, ions are mutually exchanged between two ionic compounds to form two new compounds, including a precipitate (AgCl). This represents a **double displacement reaction**.

Final Answer: $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$

Answer: (A)

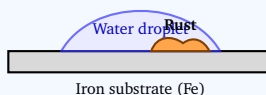
[Go Back to Question 14](#)



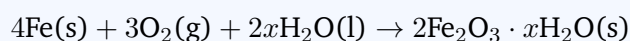
Q15.

Solution

Concept: A **chemical change** involves the breaking and making of chemical bonds, resulting in the formation of new substances with entirely different chemical and physical properties. A physical change alters only the physical state or appearance without modifying the underlying chemical identity.



Solution: Step 1: Analyze the rusting process. When iron (Fe) is exposed to oxygen (O₂) and water (H₂O), a slow electrochemical reaction occurs:



Step 2: Evaluate the products. Hydrated iron(III) oxide (rust) is formed, which has different physical and chemical properties compared to metallic iron. Since a new substance is formed, this is a chemical change.

Final Answer:

Answer: (B)

[Go Back to Question 15](#)



Q16.

Solution

Concept: A gas used to fill floating balloons must have a lower density than the surrounding air (average molar mass of air is ≈ 29 g/mol) to provide lifting buoyancy.

Solution: Step 1: Evaluate the molar masses of the options:

- Oxygen (O_2 , 32 g/mol) and Chlorine (Cl_2 , 71 g/mol) are denser than air and cannot float.
- Nitrogen (N_2 , 28 g/mol) is close to air's density and cannot provide sufficient lift.
- Hydrogen (H_2 , 2 g/mol) is extremely light and provides the highest buoyancy.

Step 2: Address the safety criteria. Although Helium (He) is the standard safe, inert, and light gas, Hydrogen (H_2) is the only gas among the listed options capable of lifting a balloon, making it the most suitable choice in this specific set.

Final Answer:

Answer: (B)

[Go Back to Question 16](#)

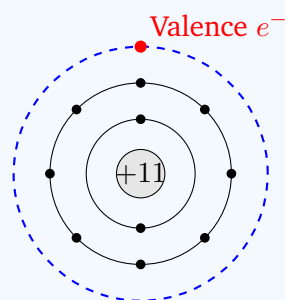


Q17.

Solution

Concept: Valency is the combining capacity of an atom in a compound.

- Atoms are stable when the outer shell is complete (octet or duet rule).
- Only valence (outermost shell) electrons participate in bonding.
- Inner electrons remain non-reactive due to strong nuclear attraction and shielding.



Sodium ($Z = 11$, Valency = 1)

The valency of a main-group element is calculated directly from its outer shell electrons (N_v):

$$\text{Valency} = \begin{cases} N_v & \text{if } N_v \leq 4 \\ 8 - N_v & \text{if } N_v > 4 \end{cases}$$

Solution:

Option A (Neutrons): Neutrons affect atomic mass and stability but do not participate in bonding, so they do not determine valency.

Option B (Outer shell electrons): Valency depends on the number of electrons in the outermost shell, as only these electrons participate in bonding. **This is correct.**

Option C (Atomic mass): Atomic mass is a nuclear property and has no role in determining chemical combining capacity.

Option D (Number of shells): Number of shells affects size and period but not valency (e.g., H and Na both have valency 1).

Final Answer:

Answer: (B)

[Go Back to Question 17](#)

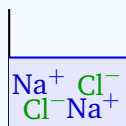


Q18.

Solution

Concept: An **electrolyte** is a substance that produces an electrically conducting solution when dissolved in a polar solvent, such as water.

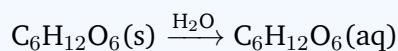
- **Strong Electrolytes:** Substances that completely (or nearly completely) dissociate into free-moving ions in aqueous solution. They conduct electricity very efficiently. Examples include strong acids, strong bases, and soluble ionic salts.
- **Weak Electrolytes:** Substances that partially dissociate in water, yielding a low concentration of ions.
- **Non-electrolytes:** Substances that dissolve in water as intact, neutral molecules and do not dissociate into ions. They do not conduct electricity.



Strong Electrolyte

Solution: Let us evaluate each of the given substances in aqueous solution:

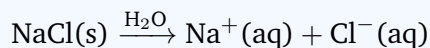
Step 1: Evaluate Glucose solution (C₆H₁₂O₆). Glucose is a covalent organic compound. When dissolved in water, it disperses as individual, neutral glucose molecules:



Since no ions are produced, it is a non-electrolyte.

Step 2: Evaluate Alcohol solution (e.g., Ethanol, C₂H₅OH). Alcohol molecules form hydrogen bonds with water but do not ionize. The solution contains neutral molecules, making it a non-electrolyte.

Step 3: Evaluate NaCl solution (Sodium chloride). Sodium chloride is a classic ionic compound with a crystal lattice of sodium (Na⁺) and chloride (Cl⁻) ions. In water, the polar water molecules easily overcome the lattice energy, leading to complete dissociation into free-moving, hydrated ions:



Because it dissociates 100% into ions, it is a strong electrolyte.

Step 4: Evaluate Urea solution (NH₂CONH₂). Urea is a covalent compound that dissolves in water as intact molecules. It does not ionize and is a non-electrolyte.

Final Answer: NaCl solution

Answer: (C)

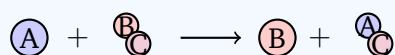
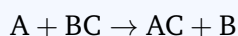
[Go Back to Question 18](#)



Q19.

Solution

Concept: A **displacement reaction** (specifically, single displacement) is a chemical reaction in which a more reactive element displaces a less reactive element from its compound or salt solution. The general representation of this reaction is:



According to the metal reactivity series, a metal situated higher in the series can easily displace any metal situated lower than it from its aqueous salt solution.

Solution: Let us analyze each of the chemical reactions described in the options:

Step 1: Analyze Option A: $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$ This is a reaction between an acid (HCl) and a base (NaOH) to form salt and water. It is a neutralization reaction, which is a type of double displacement reaction.

Step 2: Analyze Option B: $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$ Zinc (Zn) is more reactive than copper (Cu) because it lies above copper in the reactivity series. When zinc metal is placed in a copper(II) sulfate solution, the zinc atoms displace the copper ions, forming zinc sulfate and depositing metallic copper. This is a classic example of a single displacement reaction.

Step 3: Analyze Option C: $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ This is a reaction where a single reactant decomposes into two products under the influence of heat. It is a thermal decomposition reaction.

Step 4: Analyze Option D: $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$ In this reaction, hydrogen gas and chlorine gas combine to form hydrogen chloride gas. This is a combination reaction.

Final Answer: $\text{Zn} + \text{CuSO}_4$

Answer: (B)

[Go Back to Question 19](#)



Q20.

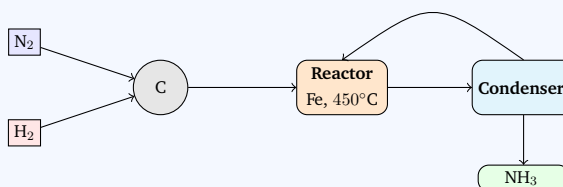
Solution

Concept: Haber process:



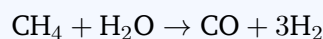
It is a reversible exothermic equilibrium reaction. Conditions are optimized using Le Chatelier's principle:

- High pressure (150–200 atm): shifts equilibrium towards NH_3 (fewer moles).
- Moderate temperature (400–450°C): compromise between yield and rate.
- Fe catalyst: increases rate without affecting equilibrium.

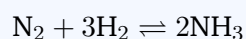


Solution: Step 1: Raw materials

- Nitrogen (N_2): obtained by fractional distillation of liquid air.
- Hydrogen (H_2): produced by steam reforming of methane:



Step 2: Main reaction Reactants are combined in a 1:3 ratio under suitable conditions:



Step 3: Eliminate incorrect options

- Oxygen: obtained from air separation, not Haber process.
- Nitrogen: reactant, not product.
- Carbon dioxide: byproduct of other industrial processes, not Haber process.

Step 4: Conclusion The Haber process produces **ammonia (NH_3)**.

Final Answer: Ammonia

Answer: (B)

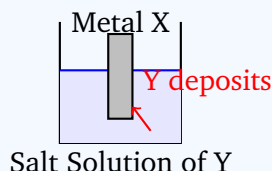
[Go Back to Question 20](#)



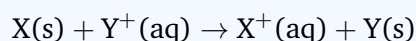
Q21.

Solution

Concept: The relative reactivity of metals can be determined by conducting single displacement reactions. If a solid metal X is placed into an aqueous solution containing ions of metal Y (Y^+), a reaction will occur only if metal X is more electropositive (more reactive) than metal Y.



In this spontaneous process, metal X loses electrons (undergoes oxidation) and dissolves, while metal Y ions gain those electrons (undergo reduction) and deposit as a solid metal on the surface of X:



If metal X is less reactive than metal Y, it cannot force its electrons onto Y^+ , and no reaction will take place.

Solution: Step 1: Interpret the experimental observation. The student observes that metal Y is deposited onto the solid strip of metal X. This physical deposition indicates that a spontaneous chemical reaction has occurred:



Step 2: Deduce the reactivity relationship. Because metal X successfully displaced metal Y from its compound, metal X has a greater tendency to lose electrons and form ions than metal Y. This proves that metal X is chemically more reactive than metal Y.

Step 3: Analyze the options.

- **Option A (X is less reactive than Y):** Incorrect, as a less reactive metal cannot displace a more reactive metal ion from solution.
- **Option B (X is more reactive than Y):** Correct, which is the required condition for displacement to occur.
- **Option C (Both have equal reactivity):** Incorrect, because an equilibrium with no net deposition would occur if their electropositive tendencies were identical.
- **Option D (No reaction occurs):** Incorrect, since the physical deposition of metal Y on X is direct visual evidence of a reaction.

Final Answer:

Answer: (B)

[Go Back to Question 21](#)

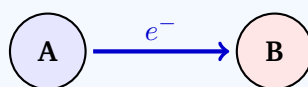


Q22.

Solution

Concept: Chemical bonds are formed to allow atoms to achieve stable outer shell configurations.

- **Ionic Bonding:** Occurs when a metallic atom with low ionization energy completely loses one or more electrons to a non-metallic atom with high electron affinity. This transfer of electrons generates oppositely charged ions (cations and anions) held together by electrostatic attraction.
- **Covalent Bonding:** Occurs when two non-metals share one or more pairs of valence electrons to satisfy their octets.



Metal (Cation) Non-metal (Anion)

Solution: Step 1: Analyze the given diagram. The diagram shows atom A and atom B, with a directional arrow pointing from A to B. The question text specifies that "metal A loses electrons to metal B forming an ionic compound."

Step 2: Relate the physical process to the options.

- **Sharing of electrons (Option A):** This describes covalent bonding, which does not result in the formation of separate charged ions.
- **Transfer of electrons (Option B):** This describes ionic bonding, where electrons are completely transferred from the electropositive metal A to the electronegative metal B. This is the correct description.
- **Sharing of protons (Option C):** Protons are held firmly in the nucleus by the strong nuclear force and are never shared or transferred during chemical reactions.
- **Transfer of neutrons (Option D):** Neutrons are also bound in the nucleus and do not participate in chemical bonding.

Final Answer:

Answer: (B)

[Go Back to Question 22](#)

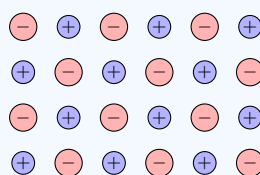


Q23.

Solution

Concept: Physical properties of solids depend on bonding:

- **Covalent molecular compounds:** Low melting points due to weak intermolecular forces; do not conduct electricity in any state.
- **Ionic compounds:** Form strong electrostatic lattices of ions, leading to:
 - High melting and boiling points
 - Conductivity in molten or aqueous state (free ions)
 - Solubility in polar solvents like water due to ion-dipole interactions



Solution: Step 1: Match the given properties with the bonding types.

- **High melting point:** Excludes covalent molecular substances.
- **Conducts electricity in molten state:** Indicates the presence of charged particles that become mobile upon melting. This is a defining characteristic of ionic compounds. (Metals conduct in both solid and molten states, but the question specifies conductivity specifically "in molten state" and "solubility in water", which is highly characteristic of ionic salts).
- **Soluble in water:** Water is a polar solvent that easily dissolves ionic compounds by hydration.

Step 2: Conclude the bonding type. These properties are the signature characteristics of a compound held together by ionic bonding (Option B).

Final Answer:

Answer: (B)

[Go Back to Question 23](#)



Q24.

Solution

Concept: In chemical reactions, matter is rearranged through the breaking and forming of chemical bonds, but the atoms themselves are neither created nor destroyed. This is formalized by the fundamental laws of chemical combination:

- **Law of Conservation of Mass:** Formulated by Antoine Lavoisier, it states that mass can neither be created nor destroyed in a chemical reaction. Therefore, the total mass of the reactants must equal the total mass of the products.
- **Law of Definite Proportions:** States that a given chemical compound always contains its component elements in a fixed ratio by mass.
- **Law of Multiple Proportions:** States that when two elements combine to form more than one compound, the masses of one element that combine with a fixed mass of the other are in a ratio of small whole numbers.
- **Avogadro's Law:** States that equal volumes of all gases under the same conditions of temperature and pressure contain equal numbers of molecules.

Solution: Step 1: Analyze the given statement. The statement says: "During a chemical reaction, the total mass of reactants remains equal to the total mass of products."

Step 2: Correlate with the laws of chemistry. This is the direct definition of the Law of conservation of mass (Option B). Mathematically, for a reaction $A + B \rightarrow C + D$:

$$\text{Mass of A} + \text{Mass of B} = \text{Mass of C} + \text{Mass of D}$$

Step 3: Evaluate the incorrect options. Options A, C, and D describe proportions of combining elements or gas volume relationships, which do not directly state that the total mass is conserved during a reaction.

Final Answer: Law of conservation of mass

Answer: (B)

[Go Back to Question 24](#)



Q25.

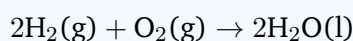
Solution

Concept: The environmental impact of burning a fuel depends on its chemical composition, state of matter, and the presence of non-combustible impurities:

- **Gaseous fuels (LPG, CNG, Hydrogen):** Burn cleanly with high efficiency because gases mix intimately with oxygen, promoting complete combustion. They contain virtually no solid impurities or heavy metals.
- **Solid fuels (Coal):** Composed of highly complex, high-carbon polymeric networks. They contain significant concentrations of non-combustible mineral matter (which forms ash upon burning) and chemical impurities such as sulfur, nitrogen, and heavy metals (e.g., mercury, lead).

Solution: Let us evaluate the combustion products of each fuel:

Step 1: Analyze Hydrogen (H₂). Hydrogen is the cleanest fuel. It burns to produce only water vapor, causing zero carbon-based pollution:



Step 2: Analyze CNG (Compressed Natural Gas) and LPG (Liquefied Petroleum Gas). CNG (mainly methane, CH₄) and LPG (mainly propane and butane) are gaseous hydrocarbons. They undergo clean, complete combustion to produce carbon dioxide and water vapor, with negligible particulate matter or sulfur dioxide.

Step 3: Analyze Coal. Coal is a solid fossil fuel with high carbon content. When burnt, its impurities and incomplete combustion release a high volume of dangerous pollutants:

- (a) Carbon dioxide (CO₂), a greenhouse gas, in much higher quantities per unit of energy than gas.
- (b) Sulfur dioxide (SO₂) and nitrogen oxides (NO_x), which cause acid rain and smog.
- (c) Particulate matter (soot/fly ash) and toxic heavy metals.

Step 4: Conclude which fuel produces maximum pollution. Coal produces the maximum environmental pollution due to its high carbon content and substantial impurities.

Final Answer:

Answer:

[Go Back to Question 25](#)



Answer Key

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

