

# JEECUP Group A Chemistry Sample Paper – 22

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 sample of hard water contains calcium bicarbonate. When this water is boiled, a white precipitate is formed. This precipitate is:

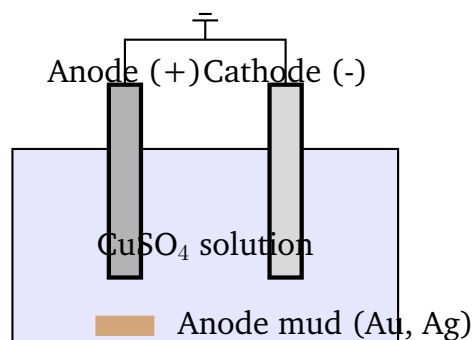
- (A)  $\text{Ca}(\text{OH})_2$
- (B)  $\text{CaCO}_3$
- (C)  $\text{CaCl}_2$
- (D)  $\text{CaSO}_4$

**Q2.** An element  $X$  belongs to Group 14 and Period 3 of the periodic table. What is the electronic configuration of the element immediately below  $X$  in the same group?

- (A) 2, 8, 4
- (B) 2, 8, 8, 4
- (C) 2, 8, 18, 4
- (D) 2, 8, 18, 8, 4

**Q3.** During the electrolytic refining of copper, the impurities like gold and silver settle down below the anode as anode mud. These impurities are left unreacted because they are:



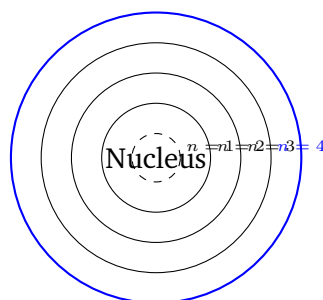


- (A) highly reactive and form soluble salts
- (B) less electropositive than copper
- (C) more electropositive than copper
- (D) strong reducing agents

**Q4.** An organic compound *A* with molecular formula  $C_2H_6O$  undergoes oxidation with alkaline  $KMnO_4$  upon heating to give compound *B*. When *A* and *B* are reacted together in the presence of a few drops of concentrated sulphuric acid, a sweet-smelling substance *C* is formed. Compound *C* is:

- (A)  $CH_3COOCH_3$
- (B)  $CH_3COOC_2H_5$
- (C)  $HCOOCH_3$
- (D)  $C_2H_5COOCH_3$

**Q5.** The maximum number of electrons that can be accommodated in the fourth energy level ( $n = 4$ ) of an atom is calculated using the formula  $2n^2$ . What is this maximum value?



- (A) 16



- (B) 32
- (C) 18
- (D) 8

**Q6.** When a piece of zinc metal is dipped into an aqueous solution of copper sulphate, the blue color of the solution fades and a reddish-brown deposit is observed. This reaction is an example of a:

- (A) Combination reaction
- (B) Decomposition reaction
- (C) Displacement reaction
- (D) Double displacement reaction

**Q7.** Which of the following aqueous solutions will turn red litmus paper blue?

- (A) Sodium chloride solution
- (B) Ammonium chloride solution
- (C) Sodium carbonate solution
- (D) Potassium sulphate solution

**Q8.** Pure iron is very soft and stretches easily when hot. To make it hard and strong, it is mixed with a small quantity of carbon. The percentage of carbon added is approximately:

- (A) 0.05%
- (B) 5.0%
- (C) 10.0%
- (D) 2.5%

**Q9.** In the reaction:  $\text{MnO}_2 + 4\text{HCl} \rightarrow \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$ , the substance that acts as the reducing agent is:

- (A)  $\text{MnO}_2$

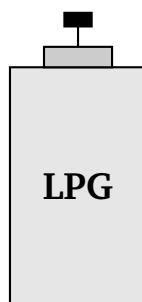


- (B) HCl
- (C)  $\text{MnCl}_2$
- (D)  $\text{H}_2\text{O}$

**Q10.** The fundamental basis for the arrangement of elements in the Modern Periodic Table is the:

- (A) Increasing order of atomic mass
- (B) Total number of neutrons
- (C) Increasing order of atomic number
- (D) Equivalent weight of the elements

**Q11.** A gas cylinder contains a mixture of liquefied petroleum gas (LPG). The major constituent of this fuel is:



- (A) Methane
- (B) Ethane
- (C) Butane
- (D) Ethene

**Q12.** Two atoms  $A$  and  $B$  combine to form a stable ionic compound. If  $A$  loses two electrons and  $B$  gains one electron, the chemical formula of the resulting compound will be:

- (A)  $\text{AB}$
- (B)  $\text{A}_2\text{B}$
- (C)  $\text{AB}_2$



(D)  $A_2B_3$

**Q13.** When a small amount of acid is added to water, a phenomenon called dilution occurs. During this process, the concentration of hydronium ions ( $H_3O^+$ ) per unit volume:

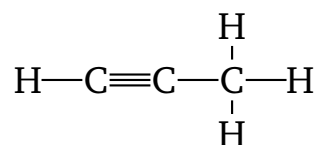
(A) Increases

(B) Decreases

(C) Remains unchanged

(D) First increases then decreases

**Q14.** The structural formula of an unsaturated hydrocarbon contains a triple bond between two carbon atoms. If the molecule contains three carbon atoms, its IUPAC name is:



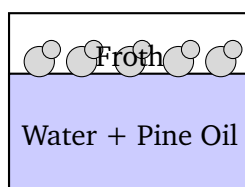
(A) Propane

(B) Propene

(C) Propyne

(D) Cyclopropene

**Q15.** Froth floatation process is a highly commercially viable method used for the concentration of which specific type of ore?



(A) Oxide ores

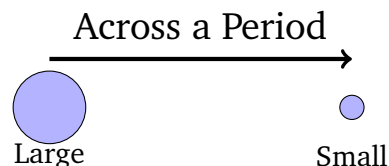
(B) Carbonate ores

(C) Sulphide ores



(D) Nitrate ores

**Q16.** Moving from left to right across a period in the Modern Periodic Table, the atomic radius generally:



- (A) Increases due to increase in nuclear charge
- (B) Decreases due to increase in effective nuclear charge
- (C) Remains constant due to same number of shells
- (D) First increases then decreases

**Q17.** A solution reacts with crushed eggshells to give a gas that turns lime-water milky. The solution contains:

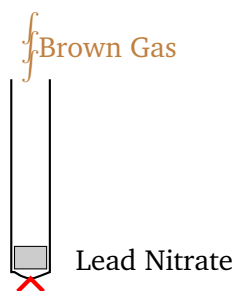
- (A) NaCl
- (B) HCl
- (C) LiCl
- (D) KCl

**Q18.** The electronic configuration of an element is 2, 8, 7. In which group and period of the Modern Periodic Table is this element located?

- (A) Group 7, Period 3
- (B) Group 17, Period 3
- (C) Group 17, Period 2
- (D) Group 7, Period 2

**Q19.** When solid lead nitrate is strongly heated in a dry boiling tube, a brown colored gas is evolved. This brown gas is:





- (A) Oxygen ( $O_2$ )
- (B) Nitrogen dioxide ( $NO_2$ )
- (C) Nitrous oxide ( $N_2O$ )
- (D) Nitric oxide ( $NO$ )

**Q20.** Two atomic species  $X$  and  $Y$  have the same mass number but different atomic numbers.  $X$  has an atomic number of 18 and a mass number of 40, while  $Y$  has an atomic number of 20 and a mass number of 40. These two species are called:

- (A) Isotopes
- (B) Isobars
- (C) Isotones
- (D) Isomers

**Q21.** Biogas is considered an excellent eco-friendly fuel. It contains up to what percentage of methane gas?

- (A) 45%
- (B) 55%
- (C) 75%
- (D) 95%

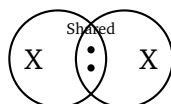
**Q22.** An element reacts with oxygen to give a compound with a high melting point. This compound is also highly soluble in water. The element is likely to be:

- (A) Calcium



- (B) Carbon
- (C) Silicon
- (D) Iron

**Q23.** What type of chemical bond is formed when two highly electronegative atoms share pairs of electrons to achieve a stable octet configuration?



- (A) Ionic bond
- (B) Covalent bond
- (C) Metallic bond
- (D) Coordinate bond

**Q24.** Vinegar is a common household solution used as a preservative. It is a dilute solution containing:

- (A) 5–8% Citric acid in water
- (B) 5–8% Acetic acid in water
- (C) 10–15% Tartaric acid in water
- (D) 5–8% Formic acid in water

**Q25.** Which of the following structural formulas represents a saturated cyclic hydrocarbon?

- (A) Benzene
- (B) Cyclohexane
- (C) Hexene
- (D) Butyne



## Detailed Solutions

Q1.

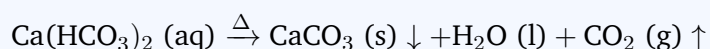
## Solution

**Concept:** Hardness of water is caused by the presence of dissolved bicarbonates, chlorides, and sulphates of calcium and magnesium. Temporary hardness is specifically due to calcium bicarbonate,  $\text{Ca}(\text{HCO}_3)_2$ , and magnesium bicarbonate,  $\text{Mg}(\text{HCO}_3)_2$ . This type of hardness can be easily removed by physical boiling, which converts soluble hydrogen carbonates into insoluble metal carbonates.

**Solution:** Step 1: Identify the chemical composition of temporary hard water. The problem states that the water contains dissolved calcium bicarbonate,  $\text{Ca}(\text{HCO}_3)_2$ , which is soluble in water and stable at room temperature.

Step 2: Analyze the chemical transformation that occurs upon thermal decomposition. When water containing calcium bicarbonate is boiled, the heat energy causes the bicarbonate ions to decompose.

Step 3: Write down the balanced chemical equation representing this thermal decomposition process:



Step 4: Analyze the products formed in the chemical reaction. The decomposition yields solid calcium carbonate ( $\text{CaCO}_3$ ), liquid water, and carbon dioxide gas which escapes into the atmosphere.

Step 5: Relate the products to the observation given in the question. The insoluble calcium carbonate ( $\text{CaCO}_3$ ) drops out of the solution, forming a characteristic white precipitate or scale on the walls of the vessel. Thus, the precipitate is calcium carbonate.

**Final Answer:**

**Answer: (B)** [Go Back to Question 1](#)



Q2.

**Solution**

**Concept:** The position of an element in the periodic table helps determine its electronic configuration and its relation to other elements within the same column. Elements belonging to the same vertical column (group) share identical valence shell configurations, while the number of occupied electron shells corresponds directly to their horizontal row (period) number.

**Solution:** Step 1: Identify the electronic configuration of element  $X$ . Since  $X$  is in Period 3, it possesses three electron shells ( $K$ ,  $L$ , and  $M$ ). Being in Group 14 (or Group IV A), it contains 4 valence electrons in its outermost shell.

Step 2: Write down the step-by-step electronic layout for element  $X$ . The core shells must be completely filled. Thus, the configuration of  $X$  is 2 for the  $K$ -shell, 8 for the  $L$ -shell, and 4 for the  $M$ -shell, which sums up to an atomic number of 14 (Silicon).

Step 3: Determine the position of the element directly below  $X$ . Going down a group in the periodic table implies moving from one period to the subsequent period. Therefore, the element situated immediately below  $X$  belongs to Period 4 of Group 14.

Step 4: Account for the addition of electrons when moving from Period 3 to Period 4 within Group 14. Moving down to Period 4 introduces the filling of the  $N$ -shell, along with the complete integration of the 3d subshell in the  $M$ -shell. This inserts an additional 18 electrons into the atomic structure.

Step 5: Determine the final configuration of the target element. The inner shells  $K$ ,  $L$ , and  $M$  will hold 2, 8, and 18 electrons respectively, while the outermost valence shell ( $N$ -shell) retains exactly 4 electrons to preserve Group 14 characteristics. This gives the sequence 2, 8, 18, 4 (Germanium, atomic number 32).

**Final Answer:**

**Answer:** (C)

[Go Back to Question 2](#)



Q3.

### Solution

**Concept:** Electrolytic refining is a process used to purify crude metals like copper. In this setup, an electric current is passed through an acidic copper sulphate electrolyte using an impure copper slab as the anode and a thin pure copper sheet as the cathode. The separation of impurities depends entirely on their standard reduction potentials and electropositive nature compared to copper.

**Solution:** Step 1: Analyze the chemical behavior at the positive electrode (anode). When electricity flows, copper atoms from the impure anode lose electrons and dissolve into the solution as  $\text{Cu}^{2+}$  ions because copper is oxidized.

Step 2: Classify the types of impurities present in crude copper. The impurities generally consist of more electropositive metals (like zinc, iron, and nickel) and less electropositive noble metals (like gold, silver, and platinum).

Step 3: Track the fate of highly electropositive impurities. Metals that are more reactive and more electropositive than copper will easily undergo oxidation, lose electrons, enter the electrolyte solution as ions, and remain dissolved without depositing at the cathode.

Step 4: Track the fate of less electropositive impurities. Noble metals such as gold (Au) and silver (Ag) have a very low tendency to lose electrons. Because they are less electropositive than copper, the applied electrical potential is insufficient to oxidize them.

Step 5: Conclude the final resting place of these noble metals. Since they do not dissolve or form ions, they simply crumble off the decomposing anode as it dissolves and collect as an insoluble residue at the bottom of the container right below the anode, forming what is known as anode mud.

**Final Answer:**

**Answer: (B)**

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Q4.

**Solution**

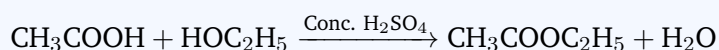
**Concept:** The problem involves a sequence of organic transformations including functional group oxidation and esterification. Primary alcohols are converted into carboxylic acids when treated with powerful oxidizing agents. Subsequently, the chemical interaction between an alcohol and a carboxylic acid under acidic catalysis yields an ester through a condensation mechanism.

**Solution:** Step 1: Identify compound *A* from its molecular formula,  $C_2H_6O$ . A stable open-chain monohydric aliphatic compound with two carbon atoms and this composition corresponds to ethanol, which has the formula  $CH_3CH_2OH$ .

Step 2: Determine the product of oxidation. When ethanol (*A*) is heated with an alkaline solution of potassium permanganate ( $KMnO_4$ ), it undergoes complete oxidation. The terminal primary alcohol group ( $-CH_2OH$ ) is converted into a carboxylic acid group ( $-COOH$ ). Thus, compound *B* is ethanoic acid (acetic acid),  $CH_3COOH$ .

Step 3: Analyze the reaction between compounds *A* and *B*. When ethanol ( $CH_3CH_2OH$ ) is mixed with ethanoic acid ( $CH_3COOH$ ) and heated with a small quantity of concentrated sulphuric acid ( $H_2SO_4$ ), an esterification reaction takes place.

Step 4: Establish the chemical equation for this esterification process:



Step 5: Identify the final sweet-smelling substance *C*. The elimination of a water molecule leaves behind ethyl ethanoate ( $CH_3COOC_2H_5$ ), which belongs to the ester family and possesses a characteristic fruity, sweet aroma.

**Final Answer:**

**Answer: (B)** [Go Back to Question 4](#)



Q5.

**Solution**

**Concept:** Bohr's atomic model states that electrons revolve around the nucleus in specific fixed circular paths called energy levels or electron shells. The maximum electron capacity of any given principal energy level depends directly on its principal quantum number ( $n$ ) and is mathematically governed by the formula set forth by Bohr and Bury.

**Solution:** Step 1: Note the given algebraic expression that dictates electron distribution. The maximum number of electrons that can occupy a single shell with principal quantum number  $n$  is given by:

$$\text{Maximum Capacity} = 2n^2$$

Step 2: Identify the specific target shell given in the problem statement. The question asks for the capacity of the fourth energy level, which corresponds to the  $N$ -shell.

Step 3: Assign the appropriate numerical value to the principal quantum number variable. For the fourth energy level, the value of  $n$  is equal to 4.

Step 4: Substitute the value of  $n = 4$  into the mathematical expression:

$$\text{Maximum Capacity} = 2 \times (4)^2$$

Step 5: Perform the arithmetic operations step-by-step. First, compute the square of the integer four:  $4 \times 4 = 16$ . Next, multiply this result by two:  $2 \times 16 = 32$ . Therefore, the fourth shell can accommodate a maximum of 32 electrons.

**Final Answer:**

**Answer: (B)**

[Go Back to Question 5](#)



Q6.

### Solution

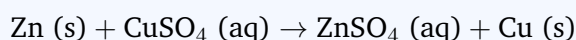
**Concept:** Chemical reactions can be classified into distinct categories based on how the reactant atoms rearrange themselves. A displacement reaction occurs when a highly reactive free element interacts with an ionic solution of a less reactive element, causing the more active metal to displace the less active metal from its compound.

**Solution:** Step 1: Identify the initial components present in the reaction system. The reactants are solid zinc metal (Zn) and a bright blue aqueous solution of copper sulphate (CuSO<sub>4</sub>).

Step 2: Consult the electrochemical activity series of metals. Zinc is positioned significantly higher than copper in the reactivity series, indicating that zinc has a stronger oxidation potential and loses electrons more readily than copper.

Step 3: Describe the chemical exchange that takes place. Because zinc is more reactive, it displaces copper ions (Cu<sup>2+</sup>) from the sulphate solution. Zinc atoms dissolve to form colorless zinc sulphate (ZnSO<sub>4</sub>), while copper ions are reduced to metallic copper.

Step 4: Formulate the balanced molecular chemical equation:



Step 5: Connect the chemical changes to the observed macroscopic results. The blue color of the solution fades away due to the consumption of Cu<sup>2+</sup> ions, and a reddish-brown layer of elemental copper deposits onto the zinc strip. This is a classic single displacement reaction.

**Final Answer:**

**Answer: (C)**

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Q7.

**Solution**

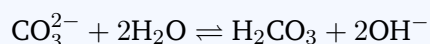
**Concept:** Litmus paper serves as an indicator to determine whether a solution is acidic, basic, or neutral. A chemical solution that changes red litmus to blue must have a basic (alkaline) character, meaning it contains an excess of hydroxyl ions ( $\text{OH}^-$ ) resulting from the salt's interaction with water, a process known as salt hydrolysis.

**Solution:** Step 1: Understand the indicator criterion. For a salt solution to turn red litmus blue, its pH must be greater than 7, which requires the salt to yield a basic solution upon dissolving in water.

Step 2: Analyze option A ( $\text{NaCl}$ ). Sodium chloride is a salt derived from a strong base ( $\text{NaOH}$ ) and a strong acid ( $\text{HCl}$ ). It undergoes no net hydrolysis, remaining perfectly neutral ( $\text{pH} = 7$ ), and does not alter the color of litmus.

Step 3: Analyze option B ( $\text{NH}_4\text{Cl}$ ). Ammonium chloride is formed from a weak base ( $\text{NH}_4\text{OH}$ ) and a strong acid ( $\text{HCl}$ ). Cationic hydrolysis produces extra hydronium ions, making the solution acidic ( $\text{pH} < 7$ ), which would turn blue litmus red.

Step 4: Analyze option C ( $\text{Na}_2\text{CO}_3$ ). Sodium carbonate is synthesized from a strong alkali ( $\text{NaOH}$ ) and a weak acid ( $\text{H}_2\text{CO}_3$ ). When dissolved, the carbonate anions hydrolyze:



This liberation of free hydroxyl ions renders the solution distinctly alkaline.

Step 5: Conclude which solution matches the requirement. Since sodium carbonate creates a basic environment with a pH above 7, it will successfully turn red litmus paper blue.

**Final Answer:** Sodium carbonate solution

**Answer:** (C)

[Go Back to Question 7](#)



Q8.

**Solution**

**Concept:** Pure elemental iron (Fe) possesses structural characteristics that make it unsuitable for heavy industrial or structural jobs. Its high ductility allows its crystal planes to slide over one another easily when hot. To modify its mechanical properties, interstitial alloying is used by adding a small non-metallic component like carbon.

**Solution:** Step 1: Examine the properties of pure iron. In its elemental state, the metallic bonds allow the atoms to shift positions smoothly under stress, making pure iron soft, highly malleable, and easily stretchable when heated.

Step 2: Define the purpose of adding carbon. Carbon atoms are much smaller than iron atoms. When introduced into molten iron, they fit into the interstitial spaces between the larger iron atoms in the crystal lattice.

Step 3: Understand how carbon alters the metal's strength. The presence of these interstitial carbon atoms disrupts the regular arrangement of the iron lattice, locking the rows of atoms in place and preventing them from sliding past one another. This increases the hardness and tensile strength of the material.

Step 4: Determine the precise industrial proportions required for standard steel reinforcement. To achieve optimal strength without making the metal brittle, only a tiny fraction of carbon is required.

Step 5: Identify the correct mass percentage. The optimal concentration of carbon added to forge high-strength steel while preserving structural integrity is approximately 0.05% to 0.1%. Thus, 0.05% is the correct choice.

**Final Answer:**

**Answer: (A)** [Go Back to Question 8](#)



Q9.

**Solution**

**Concept:** A redox reaction involves simultaneous oxidation and reduction processes. A reducing agent is a substance that reduces another reactant by losing electrons, which causes its own oxidation state to increase. Alternatively, in terms of classical chemistry, a reducing agent is a substance that gains oxygen or loses hydrogen during a chemical reaction.

**Solution:** Step 1: Write down the chemical equation and identify the individual elements involved:



Step 2: Determine the oxidation states of the elements on the reactant side. In manganese dioxide ( $\text{MnO}_2$ ), manganese (Mn) has an oxidation state of +4. In hydrochloric acid (HCl), hydrogen is +1 and chlorine (Cl) is -1.

Step 3: Determine the oxidation states of the elements on the product side. In manganese chloride ( $\text{MnCl}_2$ ), manganese drops to +2 and chlorine is -1. In elemental chlorine gas ( $\text{Cl}_2$ ), the oxidation state of chlorine is 0.

Step 4: Analyze the changes in oxidation numbers. The oxidation state of manganese decreases from +4 to +2, meaning  $\text{MnO}_2$  undergoes reduction. Conversely, the oxidation state of chlorine in HCl increases from -1 to 0.

Step 5: Identify the reducing agent. Since the chlorine atoms in hydrochloric acid (HCl) lose electrons to increase their oxidation state (undergoing oxidation), HCl acts as the reducing agent that reduces  $\text{MnO}_2$ .

**Final Answer:**

**Answer: (B)**

[Go Back to Question 9](#)



Q10.

**Solution**

**Concept:** Early scientists attempted to arrange chemical elements based on their atomic masses, which led to inconsistencies. The Modern Periodic Table resolves these issues by utilizing a fundamental physical property discovered by Henry Moseley through X-ray spectral studies, which serves as the core organizing principle of the table.

**Solution:** Step 1: Recall Mendeleev's older periodic framework. Mendeleev stated that the properties of elements are a periodic function of their atomic masses, which created issues like anomalous pairs and misplaced isotopes.

Step 2: Incorporate Henry Moseley's discovery. In 1913, Moseley demonstrated that the square root of the frequency of emitted X-rays is directly proportional to the nuclear charge (atomic number) of an element, rather than its atomic mass.

Step 3: State the Modern Periodic Law based on this discovery: "The chemical and physical properties of elements are a periodic function of their atomic numbers."

**Final Answer:**

**Answer:** (C)

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Q11.

**Solution**

**Concept:** Liquefied Petroleum Gas (LPG) is a widely used domestic and industrial fuel extracted during petroleum refining or natural gas processing. It consists of a mixture of highly flammable, low-boiling hydrocarbon gases that can be liquefied under moderate pressure at ambient temperatures.

**Solution:** Step 1: Identify the chemical components of LPG. LPG is primarily composed of low-molecular-weight alkanes, containing a mixture of propane, butane, and small amounts of isobutane or ethane.

Step 2: Evaluate the relative proportions of these components. While propane ( $C_3H_8$ ) makes up a significant fraction of the mixture, butane ( $C_4H_{10}$ ) is present in the highest percentage, typically accounting for over 60%–70% of standard commercial LPG cylinders.

Step 3: Identify the primary component responsible for the energy output. Due to its high percentage by volume, butane serves as the primary constituent and fuel source in LPG.

**Final Answer:**

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Q12.

**Solution**

**Concept:** Ionic compounds are formed when atoms transfer electrons to achieve a stable octet configuration. The resulting chemical formula must maintain strict electrical neutrality, meaning the total positive charge contributed by the cations must exactly balance the total negative charge contributed by the anions.

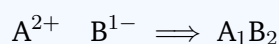
**Solution:** Step 1: Analyze the ionization behavior of atom  $A$ . The problem states that atom  $A$  loses two valence electrons. By losing two negative charges, it forms a divalent cation with a charge of  $+2$ , represented as  $A^{2+}$ .

Step 2: Analyze the ionization behavior of atom  $B$ . Atom  $B$  gains one electron to complete its valence shell. By acquiring an extra negative charge, it forms a monovalent anion with a charge of  $-1$ , represented as  $B^-$ .

Step 3: Apply the principle of electrical neutrality. The sum of the charges in the stable compound must equal zero. Let the formula be  $A_xB_y$ :

$$x \times (+2) + y \times (-1) = 0 \implies 2x = y \implies \frac{x}{y} = \frac{1}{2}$$

Step 4: Use the criss-cross method to determine the empirical ratio. Write the magnitude of the valency of each element beneath the other:



Step 5: Simplify the formula to its standard empirical form, which yields  $AB_2$ . This indicates that two  $B$  anions are required to balance the  $+2$  charge of a single  $A$  cation.

Final Answer:

Answer: (C)

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Q13.

**Solution**

**Concept:** Dilution is the process of reducing the concentration of a solute in a solution, typically by mixing in more solvent. When an acid dissolves in water, it dissociates to release hydrogen ions ( $H^+$ ), which immediately combine with water molecules to form hydronium ions ( $H_3O^+$ ).

**Solution:** Step 1: Understand the ionic composition of an acidic solution. The intensity of acidity depends directly on the number of hydronium ions ( $H_3O^+$ ) contained within a specific volume of the solution.

Step 2: Analyze the effect of adding water to the acid. Introducing an extra volume of water increases the total volume of the solvent in the container. However, this process does not generate any additional hydronium ions from the acid.

Step 3: Express concentration mathematically as a ratio:

$$\text{Concentration} = \frac{\text{Number of moles of } H_3O^+ \text{ ions}}{\text{Total volume of solution (V)}}$$

Step 4: Evaluate how changing the volume affects this ratio. Adding water increases the denominator ( $V$ ) while the numerator (total  $H_3O^+$  ions) remains constant. As a result, the overall value of the fraction decreases.

Step 5: Conclude the final effect on concentration. Because the same number of hydronium ions is now spread throughout a larger volume, the concentration of  $H_3O^+$  ions per unit volume decreases.

**Final Answer:**

**Answer: (B)**

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Q14.

**Solution**

**Concept:** The nomenclature of organic molecules follows the systematic rules established by the International Union of Pure and Applied Chemistry (IUPAC). For open-chain hydrocarbons, the name consists of a root word indicating the length of the carbon chain and a primary suffix that specifies the degree of saturation.

**Solution:** Step 1: Count the total number of carbon atoms in the main continuous chain. The problem states that the molecule contains exactly three carbon atoms. The IUPAC root word for a three-carbon chain is "prop".

Step 2: Identify the type of carbon-carbon bonds present. The compound is described as an unsaturated hydrocarbon containing a triple bond ( $-C \equiv C-$ ) between two of its carbon atoms.

Step 3: Determine the appropriate primary suffix based on bond type. Hydrocarbons with all single bonds use "-ane", those with a double bond use "-ene", and those containing a triple bond use the suffix "-yne".

Step 4: Combine the root word with the primary suffix. Combining the root "prop" with the suffix "-yne" gives the systematic name propyne.

Step 5: Verify the molecular formula using the general formula for alkynes,  $C_nH_{2n-2}$ . Substituting  $n = 3$  yields  $C_3H_{2(3)-2} = C_3H_4$ , which matches the structure of propyne ( $CH \equiv C - CH_3$ ).

**Final Answer:**

**Answer:** (C)

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Q15.

**Solution**

**Concept:** Metallurgical extraction begins with concentration methods designed to separate valuable minerals from unwanted rocky gangue. The froth floatation process is a separation technique that relies on differences in the wetting characteristics of the ore particles and the gangue impurities.

**Solution:** Step 1: Understand the working mechanism of froth floatation. The crushed ore is mixed with water, pine oil, and collecting agents. Air is then agitated through the mixture to generate a thick layer of foam at the top.

Step 2: Analyze the wetting preferences of the materials. Collecting agents selectively coat the mineral particles, making them hydrophobic (water-repellent). Consequently, these mineral particles attach to rising air bubbles and float to the surface as froth.

Step 3: Analyze the wetting preferences of the gangue. The rocky impurities are hydrophilic, meaning they are easily wetted by water. As a result, they remain submerged and settle at the bottom of the tank.

Step 4: Match this mechanism to specific mineral classes. This preferential wetting by oil occurs almost exclusively with sulphide mineral groups, such as Copper pyrites ( $\text{CuFeS}_2$ ), Galena ( $\text{PbS}$ ), and Zinc blende ( $\text{ZnS}$ ).

Step 5: Identify the target ore type. Because of these surface properties, the froth floatation process is used for the concentration of sulphide ores.

**Final Answer:**

**Answer:** (C)

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Q16.

**Solution**

**Concept:** The atomic radius represents the distance from the center of an atom's nucleus to its outermost electron shell. This distance is governed by the balance between the attractive force of the positive nucleus and the repulsive forces among the negative electrons.

**Solution:** Step 1: Analyze structural changes across a period. Moving from left to right across a horizontal period, electrons are sequentially added to the same principal energy level or valence shell.

Step 2: Analyze changes in the nucleus. For every electron added, a proton is also added to the nucleus, causing the atomic number and the total positive nuclear charge to increase steadily.

Step 3: Consider the screening effect. Because the new electrons enter the same outer shell rather than a new inner layer, the shielding effect provided by core electrons remains relatively constant.

Step 4: Determine the net effect on the valence electrons. The increase in nuclear charge, combined with constant shielding, causes the effective nuclear charge ( $Z_{\text{eff}}$ ) experienced by the outer electrons to increase.

Step 5: Conclude how this affects atomic size. This stronger positive charge pulls the outer electron cloud closer to the nucleus, shrinking the atom and causing the atomic radius to decrease across a period.

**Final Answer:** Decreases due to increase in effective nuclear charge

**Answer: (B)**

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Q17.

**Solution**

**Concept:** Eggshells are primarily composed of a common mineral compound that reacts with acids. When a metal carbonate interacts with an acid, a neutralization and displacement reaction occurs, generating a metal salt, water, and carbon dioxide gas.

**Solution:** Step 1: Identify the chemical compound that makes up eggshells. Crushed eggshells consist almost entirely of calcium carbonate,  $\text{CaCO}_3$ .

Step 2: Analyze the given observation. The reaction between the unknown solution and the eggshells produces a gas that turns lime-water milky. This chemical test confirms the presence of carbon dioxide ( $\text{CO}_2$ ).

Step 3: Determine what type of reactant releases carbon dioxide from a carbonate. Calcium carbonate must react with an acid to liberate carbon dioxide gas. Therefore, the unknown solution must be acidic.

Step 4: Evaluate the given options. Among the choices ( $\text{NaCl}$ ,  $\text{HCl}$ ,  $\text{LiCl}$ ,  $\text{KCl}$ ),  $\text{NaCl}$ ,  $\text{LiCl}$ , and  $\text{KCl}$  are neutral salts, while  $\text{HCl}$  (hydrochloric acid) is a strong mineral acid.

Step 5: Write the balanced chemical equation to confirm the reaction:



The liberated carbon dioxide gas reacts with lime-water ( $\text{Ca}(\text{OH})_2$ ) to form a white precipitate of  $\text{CaCO}_3$ , which turns the solution milky. Thus, the solution contains  $\text{HCl}$ .

**Final Answer:**

**Answer: (B)** [Go Back to Question 17](#)



Q18.

**Solution**

**Concept:** An element's electronic configuration reveals its position within the Modern Periodic Table. The total number of occupied electron shells determines its period number, while the number of valence electrons in its outermost shell determines its group assignment.

**Solution:** Step 1: Analyze the given electronic configuration, which is 2, 8, 7. Summing these values gives the total number of electrons:  $2 + 8 + 7 = 17$ . For a neutral atom, this corresponds to an atomic number of 17 (Chlorine).

Step 2: Count the total number of occupied electron shells. The configuration uses three distinct shells ( $K = 2, L = 8, M = 7$ ). Since there are three occupied shells, the element belongs to Period 3.

Step 3: Count the number of valence electrons. The outermost  $M$ -shell contains exactly 7 electrons.

Step 4: Apply group assignment rules for p-block elements. For elements with three or more valence electrons, the group number is calculated by adding 10 to the number of valence electrons:

$$\text{Group Number} = 10 + \text{Valence Electrons} = 10 + 7 = 17$$

Step 5: Combine these findings to determine the final position. The element is located in Group 17 and Period 3 of the periodic table.

**Final Answer:**

**Answer: (B)** [Go Back to Question 18](#)



Q19.

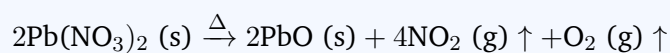
**Solution**

**Concept:** Heavy metal nitrates undergo thermal decomposition when heated, breaking down into a metal oxide, oxygen gas, and a characteristic nitrogen oxide gas. This transformation can be identified by observing the color and properties of the gaseous products.

**Solution:** Step 1: Identify the formula of the starting material. Solid lead nitrate is a white crystalline salt represented by the chemical formula  $\text{Pb}(\text{NO}_3)_2$ .

Step 2: Describe the thermal decomposition process. When solid lead nitrate is heated in a dry tube, it cracks and decomposes into simpler substances.

Step 3: Write the balanced chemical equation for this decomposition:



Step 4: Characterize the products formed. The reaction produces solid lead monoxide ( $\text{PbO}$ ), which appears yellow when cold, along with colorless oxygen gas ( $\text{O}_2$ ) and nitrogen dioxide gas ( $\text{NO}_2$ ).

Step 5: Match the observations with the correct gas. Nitrogen dioxide ( $\text{NO}_2$ ) is a toxic gas known for its distinctive reddish-brown color. Therefore, the brown gas evolved during heating is nitrogen dioxide.

**Final Answer:**

**Answer: (B)**

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Q20.

**Solution**

**Concept:** Atomic species can be classified into groups like isotopes, isobars, and isotones based on the relationships between their atomic numbers ( $Z$ ) and mass numbers ( $A$ ). These relationships reflect differences in the proton and neutron counts within their nuclei.

**Solution:** Step 1: Define the terms used to classify atomic species. Isotopes are atoms of the same element that have the same atomic number but different mass numbers. Isobars are atoms of different elements that share the same mass number but have different atomic numbers.

Step 2: Analyze the properties of species  $X$  given in the prompt. Species  $X$  has an atomic number ( $Z$ ) of 18 and a mass number ( $A$ ) of 40 (Argon).

Step 3: Analyze the properties of species  $Y$  given in the prompt. Species  $Y$  has an atomic number ( $Z$ ) of 20 and a mass number ( $A$ ) of 40 (Calcium).

Step 4: Compare the atomic numbers and mass numbers of both species. Both  $X$  and  $Y$  have the same mass number ( $A = 40$ ), but they have different atomic numbers ( $Z_X = 18$  and  $Z_Y = 20$ ).

Step 5: Apply the correct classification term. Since these are atoms of different chemical elements that share an identical total nucleon count (mass number) but differ in proton count, they are classified as isobars.

**Final Answer:**

**Answer: (B)**

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Q21.

**Solution**

**Concept:** Biogas is a renewable energy source produced by the anaerobic digestion of organic matter, such as agricultural waste, manure, and sewage, by methanogenic bacteria. It serves as an eco-friendly alternative to fossil fuels because it burns cleanly without producing smoke.

**Solution:** Step 1: Identify the chemical composition of biogas. Biogas is a mixture of gases, primarily consisting of methane ( $\text{CH}_4$ ) and carbon dioxide ( $\text{CO}_2$ ), along with trace amounts of hydrogen, nitrogen, and hydrogen sulphide.

Step 2: Determine which component acts as the primary fuel source. Methane is the combustible component of the mixture that burns to release thermal energy, making it the primary constituent of biogas.

Step 3: Evaluate the typical percentage of methane in high-quality biogas. Depending on the organic source material and processing conditions, the methane content generally ranges from 50% to 75%.

Step 4: Identify the maximum standard efficiency value. Under optimal anaerobic conditions, biogas can contain up to 75% methane gas, which maximizes its heating efficiency.

**Final Answer:**

**Answer: (C)** [Go Back to Question 21](#)



Q22.

**Solution**

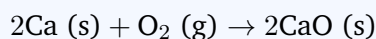
**Concept:** The chemical bonding and physical properties of oxides depend on whether they are derived from metallic or non-metallic elements. Metals react with oxygen to form basic oxides that exist as ionic crystalline lattices with high melting points, and many of these oxides dissolve in water to form alkaline solutions.

**Solution:** Step 1: Analyze the physical properties described in the problem. The element reacts with oxygen to yield an oxide that has a high melting point and dissolves readily in water. High melting points are a characteristic feature of giant ionic crystal lattices.

Step 2: Evaluate option B (Carbon) and option C (Silicon). Carbon forms carbon dioxide (CO<sub>2</sub>), which is a covalent gas with a very low melting point. Silicon forms silicon dioxide (SiO<sub>2</sub>), which has a high melting point but is entirely insoluble in water.

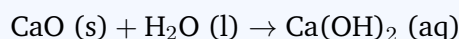
Step 3: Evaluate option D (Iron). Iron forms iron oxides like Fe<sub>2</sub>O<sub>3</sub>, which have high melting points but are completely insoluble in water.

Step 4: Evaluate option A (Calcium). Calcium is an alkaline earth metal that reacts with oxygen to form calcium oxide (CaO):



Calcium oxide is an ionic compound with a very high melting point (around 2572°C).

Step 5: Verify the water solubility of calcium oxide. When added to water, calcium oxide reacts vigorously to form calcium hydroxide (Ca(OH)<sub>2</sub>), a soluble alkali:



This matches all the criteria given in the question, confirming that the element is calcium.

**Final Answer:**

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Q23.

**Solution**

**Concept:** Chemical bonds are formed when atoms interact to achieve a stable electronic configuration, typically resembling the nearest noble gas octet. The type of bond that forms depends on the electronegativity values of the participating atoms.

**Solution:** Step 1: Analyze the characteristics of the atoms involved. The problem describes an interaction between two highly electronegative atoms. Highly electronegative elements (like non-metals) have a strong tendency to attract electrons rather than lose them.

Step 2: Determine why an ionic bond cannot form. An ionic bond requires a large electronegativity difference, where a metal transfers electrons to a non-metal. Since both atoms are highly electronegative, neither will readily give up an electron to the other.

Step 3: Describe the alternate mechanism for achieving stability. To complete their valence shells and achieve a stable octet, the two non-metallic atoms share one or more pairs of valence electrons.

Step 4: Identify the bond type associated with electron sharing. A chemical bond formed by the mutual sharing of electron pairs between two atoms is defined as a covalent bond.

**Final Answer:**

**Answer: (B)**

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Q24.

**Solution**

**Concept:** Vinegar is a common liquid used in culinary applications, food preservation, and pickling. It is produced through a two-step fermentation process where sugars are converted into ethanol by yeast, which is then oxidized into a weak carboxylic acid by acetic acid bacteria.

**Solution:** Step 1: Identify the primary chemical component of vinegar. Vinegar owes its sour taste and preservative properties to ethanoic acid, which is commonly known as acetic acid ( $\text{CH}_3\text{COOH}$ ).

Step 2: Evaluate the concentration of this acid in standard commercial vinegar. Pure acetic acid is hazardous, so commercial vinegar is highly diluted with water to ensure it is safe for consumption.

Step 3: State the standard industrial composition. Standard household white vinegar is an aqueous solution that contains approximately 5% to 8% acetic acid by volume.

**Final Answer:**

**Answer: (B)**

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Q25.

**Solution**

**Concept:** Hydrocarbons can be classified based on their structural arrangements and degrees of saturation. A saturated hydrocarbon contains only single carbon-carbon bonds (C – C), maximizing the number of hydrogen atoms bound to the carbon skeleton. A cyclic hydrocarbon features a carbon chain locked into a closed ring geometry.

**Solution:** Step 1: Analyze option A (Benzene). Benzene has the molecular formula  $C_6H_6$  and consists of a six-membered ring with alternating double bonds. Because it contains double bonds, it is an unsaturated aromatic hydrocarbon.

Step 2: Analyze option C (Hexene) and option D (Butyne). Hexene contains a double bond ( $-C = C-$ ) and butyne contains a triple bond ( $-C \equiv C-$ ). Both are open-chain, unsaturated hydrocarbons.

Step 3: Analyze option B (Cyclohexane). The prefix "cyclo-" indicates that the carbon atoms are arranged in a closed ring, while the suffix "-ane" confirms that all carbon-carbon bonds are single bonds, meaning the molecule is fully saturated.

Step 4: Verify the molecular structure of cyclohexane. It consists of a ring of six carbon atoms, with each carbon bonded to two hydrogen atoms, giving a molecular formula of  $C_6H_{12}$ . This structure satisfies all the criteria for a saturated cyclic hydrocarbon.

**Final Answer:**

**Answer: (B)**

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## Answer Key

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

