

# JEECUP Group A Chemistry Sample Paper – 19

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.** Which of the following sets of quantum numbers represents the outermost electron of an atom with the atomic number 19?

- (A)  $n = 4, l = 0, m_l = 0, m_s = +\frac{1}{2}$
- (B)  $n = 3, l = 2, m_l = 0, m_s = -\frac{1}{2}$
- (C)  $n = 4, l = 1, m_l = 0, m_s = +\frac{1}{2}$
- (D)  $n = 3, l = 1, m_l = 1, m_s = -\frac{1}{2}$

**Q2.** When a small piece of sodium metal is dropped into ethanol, a gas is evolved with a brisk effervescence. Which gas is liberated during this reaction?

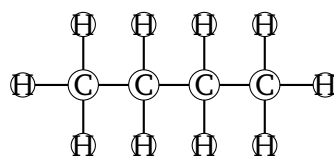
- (A) Oxygen
- (B) Hydrogen
- (C) Carbon dioxide
- (D) Methane

**Q3.** An element  $X$  forms a chloride with the formula  $XCl_2$ , which is a solid with a high melting point.  $X$  would most likely be in the same group of the Periodic Table as:



- (A) Sodium
- (B) Magnesium
- (C) Aluminium
- (D) Silicon

**Q4.** What is the total number of covalent bonds present in one molecule of butane ( $C_4H_{10}$ )?



- (A) 10
  - (B) 12
  - (C) 13
  - (D) 14
- Q5.** A solution turns red litmus paper blue. The pH of this solution is most likely to be:
- (A) 2
  - (B) 5
  - (C) 7
  - (D) 10
- Q6.** During the roasting of copper pyrites ( $CuFeS_2$ ), the gas evolved which turns acidified potassium dichromate solution green is:
- (A)  $H_2S$
  - (B)  $SO_2$
  - (C)  $CO_2$
  - (D)  $SO_3$



- Q7.** When hydrogen sulphide gas is passed through a blue solution of copper sulphate, a black precipitate of copper sulphide is obtained and the sulphuric acid remains in the solution. This reaction is an example of a:
- (A) Combination reaction
  - (B) Displacement reaction
  - (C) Decomposition reaction
  - (D) Double displacement reaction
- Q8.** Which of the following hydrocarbons will undergo an addition reaction when treated with bromine water?
- (A)  $C_2H_6$
  - (B)  $C_3H_8$
  - (C)  $C_3H_6$
  - (D)  $CH_4$
- Q9.** The electronic configuration of an element is 2, 8, 7. To which period and group of the modern periodic table does this element belong?
- (A) Period 3, Group 17
  - (B) Period 2, Group 17
  - (C) Period 3, Group 7
  - (D) Period 4, Group 7
- Q10.** Which chemical compound is chiefly used as the primary component in plastering fractured bones and making toys?
- (A)  $CaSO_4 \cdot 2H_2O$
  - (B)  $CaSO_4 \cdot \frac{1}{2}H_2O$
  - (C)  $CaCO_3$
  - (D)  $CaOCl_2$



**Q11.** The nature of the chemical bond formed between a metal atom with low ionization energy and a non-metal atom with high electron affinity is typically:

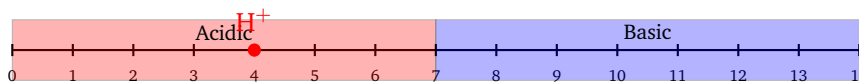


- (A) Covalent
  - (B) Coordinate
  - (C) Electrovalent
  - (D) Metallic
- Q12.** What happens when iron filings are added to a dilute solution of hydrochloric acid?
- (A) Hydrogen gas and iron(II) chloride are produced.
  - (B) Chlorine gas and iron hydroxide are produced.
  - (C) No chemical reaction takes place.
  - (D) Iron salt and water are formed.
- Q13.** In the extraction of aluminium from purified alumina by the Hall-Heroult process, cryolite ( $\text{Na}_3\text{AlF}_6$ ) is added to:
- (A) Increase the rate of purification of alumina
  - (B) Minimize the oxidation of the carbon anode
  - (C) Lower the melting point and increase the electrical conductivity of the melt
  - (D) Dissolve the impurities present in alumina
- Q14.** The major constituent of Liquefied Petroleum Gas (LPG) used as a domestic fuel is:
- (A) Methane
  - (B) Ethane
  - (C) Butane



(D) Ethene

**Q15.** An aqueous solution has a hydrogen ion concentration of  $1 \times 10^{-4}$  mol/L. The nature of this solution and its pOH value are respectively:



- (A) Acidic, 4
- (B) Basic, 10
- (C) Acidic, 10
- (D) Basic, 4

**Q16.** Which of the following oxides shows both acidic as well as basic characteristics (amphoteric oxide)?

- (A)  $\text{Na}_2\text{O}$
- (B)  $\text{SO}_2$
- (C)  $\text{Al}_2\text{O}_3$
- (D)  $\text{CaO}$

**Q17.** In the balanced chemical equation  $a\text{MnO}_2 + b\text{HCl} \rightarrow c\text{MnCl}_2 + d\text{H}_2\text{O} + e\text{Cl}_2$ , the values of stoichiometric coefficients  $a$ ,  $b$ , and  $d$  are respectively:

- (A) 1, 4, 2
- (B) 1, 2, 1
- (C) 2, 4, 2
- (D) 1, 4, 1

**Q18.** Which of the following pairs of elements exhibit diagonal relationship in the periodic table?

Li	Be
Na	Mg



- (A) Li and Mg
- (B) Na and K
- (C) Be and Mg
- (D) B and Al

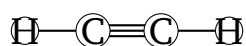
**Q19.** The chemical formula of the rust formed on the surface of an iron object left in moist air for a long time is:

- (A)  $\text{Fe}_3\text{O}_4$
- (B)  $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$
- (C)  $\text{FeCO}_3$
- (D)  $\text{Fe}(\text{OH})_2$

**Q20.** When carbon dioxide gas is passed through lime water for a short duration, it turns milky due to the formation of an insoluble precipitate. If the gas is passed continuously for a longer duration, the milkiness disappears because of the formation of:

- (A)  $\text{Ca}(\text{OH})_2$
- (B)  $\text{CaCO}_3$
- (C)  $\text{Ca}(\text{HCO}_3)_2$
- (D)  $\text{CaO}$

**Q21.** The type of hybridisation of the carbon atoms involved in the molecule of ethyne ( $\text{C}_2\text{H}_2$ ) is:

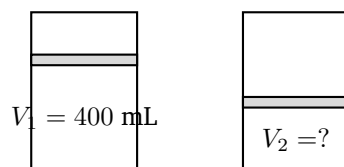


- (A)  $sp^3$
- (B)  $sp^2$
- (C)  $sp$
- (D)  $dsp^2$

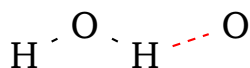


- Q22.** A sample of gas occupies a volume of 400 mL at a pressure of 760 mm Hg. If the temperature is kept constant, what will be its volume when the pressure is increased to 950 mm Hg?

$$P_1 = 760 \text{ mmHg} \quad P_2 = 950 \text{ mmHg}$$



- (A) 320 mL  
(B) 500 mL  
(C) 380 mL  
(D) 420 mL
- Q23.** Which of the following metals can displace zinc from its salt solution?
- (A) Copper  
(B) Iron  
(C) Magnesium  
(D) Lead
- Q24.** The functional group present in the organic compound propanone is:
- (A)  $-\text{CHO}$   
(B)  $-\text{OH}$   
(C)  $-\text{COOH}$   
(D)  $> \text{C} = \text{O}$
- Q25.** Which type of bonding accounts for the high boiling point of water compared to hydrogen sulphide ( $\text{H}_2\text{S}$ )?



- (A) Metallic bonding



- (B) Hydrogen bonding
- (C) Ionic bonding
- (D) Coordinate bonding



## Detailed Solutions

Q1.

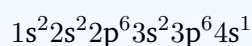
## Solution

**Concept:**

The electronic configuration of an atom is dictated by its atomic number ( $Z$ ). The outermost or valence electron's position can be specified precisely using the four quantum numbers: principal quantum number ( $n$ ), azimuthal quantum number ( $l$ ), magnetic quantum number ( $m_l$ ), and spin quantum number ( $m_s$ ). These quantum numbers follow specific selection rules based on the Aufbau principle and Pauli's exclusion principle.

**Solution:**

Step 1: The given atomic number is  $Z = 19$ , which corresponds to Potassium (K). We write its complete ground-state electronic configuration following the Aufbau principle:



Step 2: Identify the outermost shell and the orbital containing the valence electron. The highest principal quantum number is  $n = 4$ . The last electron enters the  $4s$  orbital. Therefore, the valence electron resides in the  $4s^1$  subshell.

Step 3: Determine the value of the principal quantum number ( $n$ ). Since the electron is in the fourth shell, we have:

$$n = 4$$

Step 4: Determine the value of the azimuthal quantum number ( $l$ ). For an  $s$  subshell, the value of  $l$  is always fixed:

$$l = 0$$

Step 5: Determine the value of the magnetic quantum number ( $m_l$ ). The range of  $m_l$  goes from  $-l$  to  $+l$ . For  $l = 0$ , there is only one possible value:

$$m_l = 0$$

Step 6: Determine the value of the spin quantum number ( $m_s$ ). Since there is a single electron in this orbital, its spin can be either  $+\frac{1}{2}$  or  $-\frac{1}{2}$ . Looking at the options, the value given is:

$$m_s = +\frac{1}{2}$$

Step 7: Combine all the values to form the complete set of quantum numbers: ( $n = 4, l = 0, m_l = 0, m_s = +\frac{1}{2}$ ).

**Final Answer:**  $n = 4, l = 0, m_l = 0, m_s = +\frac{1}{2}$

Answer: (A)

[Go Back to Question 1](#)



Q2.

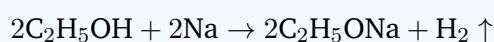
**Solution****Concept:**

Alcohols react with highly reactive alkali metals such as sodium to form metal alkoxides and liberate a gaseous byproduct. This reaction demonstrates the acidic character of the alcohol, where the O–H bond is cleaved by the strongly electropositive alkali metal.

**Solution:**

Step 1: Write down the chemical formulas for the reactants involved. Ethanol is a primary alcohol with the formula  $C_2H_5OH$ , and sodium metal is represented by Na.

Step 2: Formulate the chemical equation for the displacement reaction. The sodium atom replaces the acidic hydrogen atom present in the hydroxyl group ( $-OH$ ) of the ethanol molecule.



Step 3: Identify the products formed. The organic product is sodium ethoxide ( $C_2H_5ONa$ ), and the gaseous product is molecular hydrogen ( $H_2$ ).

Step 4: Analyze the observations of the reaction. The release of hydrogen gas causes rapid bubbling and fizzing in the test tube, which is described macroscopically as brisk effervescence.

Step 5: Verify the nature of the gas. Hydrogen is a colorless, odorless gas that burns with a characteristic pop sound when a burning splinter is brought near the mouth of the vessel, confirming its identity.

**Final Answer:**

[Go Back to Question 2](#)



Q3.

**Solution****Concept:**

The periodic table organizes elements with similar chemical properties into vertical columns called groups. Elements belonging to the same group exhibit identical valency and form compounds with analogous chemical formulas when reacting with a common non-metal like chlorine.

**Solution:**

Step 1: Analyze the chemical formula of the given metal chloride, which is  $XCl_2$ . Chlorine (Cl) is a halogen belonging to Group 17 and consistently exhibits a valency or oxidation state of  $-1$  in simple binary chlorides.

Step 2: Apply the criss-cross method of valency to deduce the valency of element  $X$ . For the compound to be electrically neutral, the single atom of  $X$  must balance the charges of two chlorine atoms:

$$\text{Valency of } X \times 1 + (-1) \times 2 = 0 \implies \text{Valency of } X = +2$$

Step 3: Identify the group in the modern periodic table where elements possess a valency of 2. The alkaline earth metals belonging to Group 2 have two valence electrons and show a stable  $+2$  oxidation state.

Step 4: Evaluate the given options based on their group placement and common valencies:

- Sodium (Na) belongs to Group 1 and has a valency of 1, forming NaCl.
- Magnesium (Mg) belongs to Group 2 and has a valency of 2, forming  $MgCl_2$ .
- Aluminium (Al) belongs to Group 13 and has a valency of 3, forming  $AlCl_3$ .
- Silicon (Si) belongs to Group 14 and has a valency of 4, forming  $SiCl_4$ .

Step 5: Conclude that Magnesium matches the valency of element  $X$  perfectly, and  $MgCl_2$  is a high-melting ionic crystalline solid.

**Final Answer:**

**Answer: (B)** [Go Back to Question 3](#)



Q4.

**Solution****Concept:**

An alkane with the general formula  $C_nH_{2n+2}$  is comprised entirely of single covalent bonds. To find the total number of covalent bonds, we must calculate the sum of all carbon-carbon (C – C) single bonds and all carbon-hydrogen (C – H) single bonds present within the molecular architecture.

**Solution:**

Step 1: Identify the given molecule as butane, which has the chemical formula  $C_4H_{10}$ . It is a saturated straight-chain hydrocarbon.

Step 2: Determine the number of carbon-carbon (C – C) single covalent bonds. For a straight chain containing  $n$  carbon atoms, the number of linkages connecting them is always equal to  $n - 1$ :

$$\text{Number of C – C bonds} = 4 - 1 = 3$$

Step 3: Determine the number of carbon-hydrogen (C – H) single covalent bonds. Each hydrogen atom forms exactly one single covalent bond with a carbon atom. Therefore, the number of C – H bonds is exactly equal to the total number of hydrogen atoms:

$$\text{Number of C – H bonds} = 10$$

Step 4: Compute the total number of covalent bonds by summing up both categories of chemical bonds calculated in the previous steps:

$$\text{Total Covalent Bonds} = (\text{C – C bonds}) + (\text{C – H bonds})$$

$$\text{Total Covalent Bonds} = 3 + 10 = 13$$

Step 5: Double check by tracing the structure:  $H_3C - CH_2 - CH_2 - CH_3$ . We count  $3 + 1 + 2 + 1 + 2 + 1 + 3 = 13$  total shared electron pairs.

Final Answer:

Answer: (C)

[Go Back to Question 4](#)



Q5.

**Solution****Concept:**

Indicators change color depending on the hydrogen ion concentration ( $H^+$ ) of the environment. Litmus paper is a common tool used to determine whether a solution is acidic, neutral, or basic. The pH scale ranges from 0 to 14, where values below 7 indicate acidity, exactly 7 indicates neutrality, and values above 7 indicate basicity.

**Solution:**

Step 1: Analyze the observation given in the problem statement. The unknown solution turns red litmus paper blue.

Step 2: Recall the characteristic behavior of litmus indicator in different chemical media. Acidic solutions turn blue litmus paper red, while basic (alkaline) solutions turn red litmus paper blue.

Step 3: Deduce the chemical nature of the solution based on the litmus test. Since it turns red litmus to blue, the solution must be basic or alkaline in nature.

Step 4: Correlate the nature of the basic solution with the corresponding range on the pH scale. Alkaline solutions possess a pH value strictly greater than 7:

$$pH > 7$$

Step 5: Evaluate the values given in the multiple-choice options:

- A pH of 2 is strongly acidic.
- A pH of 5 is weakly acidic.
- A pH of 7 is completely neutral.
- A pH of 10 is basic/alkaline.

Step 6: Select 10 as the only value satisfying the condition of being greater than 7.

**Final Answer:**

**Answer: (D)**

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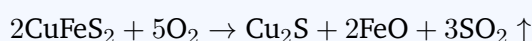
Q6.

**Solution****Concept:**

Roasting is a metallurgical process where sulphide ores are heated intensely in the presence of excess air or oxygen to convert them into metal oxides, releasing a gaseous non-metal oxide. The chemical property of the released gas can be verified using specific oxidizing agents like acidified potassium dichromate ( $K_2Cr_2O_7$ ).

**Solution:**

Step 1: Write down the chemical equation for the roasting of copper pyrites ( $CuFeS_2$ ) in the presence of oxygen ( $O_2$ ):



Step 2: Identify the gas liberated during this thermal oxidation process. The major gas evolved from the breakdown of the sulphide mineral matrix is sulphur dioxide ( $SO_2$ ).

Step 3: Analyze the interaction of sulphur dioxide gas with an acidified solution of potassium dichromate. Sulphur dioxide acts as a strong reducing agent.

Step 4: Write out the redox reaction between  $SO_2$  and  $K_2Cr_2O_7$  in an acidic medium. The orange dichromate ion ( $Cr_2O_7^{2-}$ ) containing chromium in the +6 oxidation state is reduced to the green chromium ion ( $Cr^{3+}$ ):



Step 5: Identify the substance responsible for the green coloration. The formation of chromium sulphate,  $Cr_2(SO_4)_3$ , imparts a clear green color to the solution, confirming that the gas is  $SO_2$ .

Final Answer:

Answer: (B) [Go Back to Question 6](#)



Q7.

### Solution

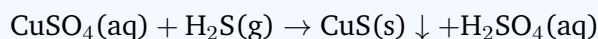
**Concept:**

Chemical reactions can be classified based on how the atoms or groups of atoms rearrange themselves. A double displacement reaction involves an exchange of ions between two reacting compounds to generate two entirely new chemical species, often resulting in the formation of an insoluble precipitate.

**Solution:**

Step 1: Identify and write down the chemical formulas of the reactants mentioned in the question. Hydrogen sulphide gas is  $\text{H}_2\text{S}$ , and copper sulphate in aqueous solution is  $\text{CuSO}_4$ .

Step 2: Construct the chemical equation representing the transformation. When these two substances interact, they undergo mutual exchange of their ionic partners:



Step 3: Analyze the nature of the products. Copper ions ( $\text{Cu}^{2+}$ ) combine with sulphide ions ( $\text{S}^{2-}$ ) to form a black solid precipitate of copper sulphide ( $\text{CuS}$ ). Simultaneously, hydrogen ions ( $\text{H}^+$ ) pair with sulphate ions ( $\text{SO}_4^{2-}$ ) to yield sulphuric acid ( $\text{H}_2\text{SO}_4$ ).

Step 4: Compare this mechanism with standard reaction types:

- Combination involves two reactants joining to form one product.
- Displacement involves a single active element displacing a less active element.
- Decomposition involves a single reactant breaking down.
- Double displacement involves two ionic compounds exchanging partners ( $\text{AB} + \text{CD} \rightarrow \text{AD} + \text{CB}$ ).

Step 5: Conclude that the reaction fits perfectly into the category of a double displacement reaction.

**Final Answer:** Double displacement reaction

**Answer: (D)**

[Go Back to Question 7](#)



Q8.

**Solution****Concept:**

Hydrocarbons are broadly split into saturated hydrocarbons (alkanes) and unsaturated hydrocarbons (alkenes and alkynes). Saturated hydrocarbons contain only single carbon-carbon bonds and undergo substitution reactions. Unsaturated hydrocarbons possess double or triple carbon-carbon bonds and readily undergo addition reactions across these multiple bonds, decoloring bromine water in the process.

**Solution:**

Step 1: Examine the chemical formulas of the options provided to determine their homologous series using general formulas:

- Alkanes follow  $C_nH_{2n+2}$
- Alkenes follow  $C_nH_{2n}$
- Alkynes follow  $C_nH_{2n-2}$

Step 2: Classify  $C_2H_6$  (Ethane). For  $n = 2$ ,  $2n + 2 = 6$ . It matches the alkane formula, meaning it is saturated and cannot undergo addition reactions.

Step 3: Classify  $C_3H_8$  (Propane). For  $n = 3$ ,  $2n + 2 = 8$ . It is an alkane, meaning it is saturated.

Step 4: Classify  $CH_4$  (Methane). For  $n = 1$ ,  $2n + 2 = 4$ . It is the simplest alkane and is saturated.

Step 5: Classify  $C_3H_6$  (Propene). For  $n = 3$ , the number of hydrogen atoms is  $2n = 6$ . This matches the general formula of an alkene perfectly, indicating the presence of a carbon-carbon double bond ( $CH_3 - CH = CH_2$ ).

Step 6: Since propene is unsaturated, it undergoes an electrophilic addition reaction with bromine water, adding  $Br_2$  across the double bond to form 1,2-dibromopropane and discharging the brown color of bromine.

**Final Answer:**

**Answer:** (C)

[Go Back to Question 8](#)



Q9.

**Solution****Concept:**

The position of an element within the modern periodic table can be determined from its ground-state electronic configuration. The total number of energy shells occupied by electrons corresponds directly to the period number, while the number of electrons in the outermost valence shell dictates the group number.

**Solution:**

Step 1: Identify the electronic configuration given in the problem statement: 2, 8, 7. Summing these values gives the atomic number:

$$Z = 2 + 8 + 7 = 17$$

This element is Chlorine (Cl).

Step 2: Determine the period number. Count the total number of electron shells listed in the configuration. There are three distinct shells occupied by electrons (K = 2, L = 8, M = 7). Therefore, the element is located in Period 3.

Step 3: Determine the group number. Look at the number of valence electrons in the outermost shell. Here, the outermost shell (M shell) contains 7 electrons.

Step 4: Apply the group numbering rules for main group elements (p-block). For elements with 3 or more valence electrons, the group number is found by adding 10 to the count of valence electrons:

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

Step 5: Combine both conclusions. The element resides in Period 3 and Group 17 of the modern periodic table.

**Final Answer:**

**Answer: (A)**

[Go Back to Question 9](#)



Q10.

**Solution****Concept:**

Calcium sulphate forms hydrates with varying amounts of water of crystallization. Controlled thermal dehydration of gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) at a precise temperature produces a hemihydrate compound widely known as Plaster of Paris, which sets into a hard solid mass upon rehydration.

**Solution:**

Step 1: Recall the industrial manufacturing of Plaster of Paris. When gypsum is heated carefully to approximately 373 K ( $100^\circ\text{C}$ ), it loses three-quarters of its water of crystallization:



Step 2: Analyze the chemical formula of the resulting product. It is Calcium Sulphate Hemihydrate, denoted chemically as  $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ .

Step 3: Review the physical properties and primary applications of this material. Plaster of Paris forms a workable paste when mixed with water that hardens into a rigid shape. This makes it ideal for supporting fractured bones in orthopedics, as well as casting sculptures and toys.

Step 4: Evaluate the formulas listed in the choices:

- $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  is gypsum, the fully hydrated precursor.
- $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$  is Plaster of Paris.
- $\text{CaCO}_3$  is calcium carbonate (limestone).
- $\text{CaOCl}_2$  is calcium oxychloride (bleaching powder).

Step 5: Conclude that option B is the correct formula for the compound used.

**Final Answer:**  $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$

**Answer: (B)**

[Go Back to Question 10](#)



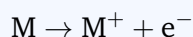
Q11.

**Solution****Concept:**

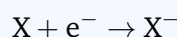
Chemical bonds are formed to minimize the potential energy of the interacting atoms. When an element that easily loses electrons interacts with an element that strongly attracts electrons, a complete transfer of valence electrons takes place, giving rise to an electrostatic attraction between the resulting ions.

**Solution:**

Step 1: Analyze the properties of the first reactant described as a metal atom with low ionization energy. Ionization energy is the energy required to remove an electron from an isolated gaseous atom. A low value means the metal atom can readily lose its outer valence electrons to form a positively charged cation:



Step 2: Analyze the properties of the second reactant described as a non-metal atom with high electron affinity. Electron affinity is the energy released when an electron is added to a neutral gaseous atom. A high electron affinity means the non-metal atom strongly attracts and readily accepts an extra electron to form a stable, negatively charged anion:



Step 3: Consider the outcome when these two species interact. The electron lost by the metal is completely transferred to the non-metal. This produces oppositely charged ions ( $M^{+}$  and  $X^{-}$ ).

Step 4: Identify the force holding these ions together. The strong coulombic or electrostatic force of attraction acting between the cation and anion binds them into a rigid lattice.

Step 5: Identify the name given to this bond type. A bond formed via complete electron transfer and governed by electrostatic attraction is known as an electrovalent bond or an ionic bond.

**Final Answer:**

**Answer:** (C)

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Q12.

**Solution****Concept:**

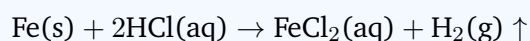
Metals react with mineral acids based on their positioning relative to hydrogen in the electrochemical activity series. Metals situated above hydrogen are more reactive and can successfully reduce hydrogen ions ( $H^+$ ) from dilute acids into elemental hydrogen gas while undergoing oxidation themselves.

**Solution:**

Step 1: Identify the reactants in the given process: iron filings (Fe) and dilute hydrochloric acid (HCl).

Step 2: Consult the metal activity series to assess feasibility. Iron (Fe) is positioned above hydrogen (H) in the reactivity hierarchy. This confirms that iron is sufficiently reactive to displace hydrogen from its acid solution.

Step 3: Formulate the balanced molecular chemical equation for this single displacement reaction. Iron reacts with hydrochloric acid to yield iron(II) chloride and hydrogen gas:



Step 4: Analyze the products formed during the chemical transformation. The products are iron(II) chloride ( $FeCl_2$ ) and hydrogen gas ( $H_2$ ).

Step 5: Match these chemical products with the given statements. Option A correctly states that hydrogen gas and iron(II) chloride are produced.

**Final Answer:**

Hydrogen gas and iron(II) chloride are produced.

**Answer: (A)**[Go Back to Question 12](#)

Q13.

**Solution****Concept:**

The extraction of highly reactive metals like aluminium cannot be carried out via conventional carbon reduction. Instead, it is achieved through the electrolytic reduction of purified alumina ( $\text{Al}_2\text{O}_3$ ) dissolved in a molten solvent bath during the Hall-Heroult industrial process.

**Solution:**

Step 1: Examine the physical limitations of pure alumina ( $\text{Al}_2\text{O}_3$ ). Alumina has an exceptionally high melting point of approximately 2323 K ( $2050^\circ\text{C}$ ), and it is a poor conductor of electricity in its solid and molten states.

Step 2: Operating an electrolysis cell at such an elevated temperature is economically unviable and technically challenging, as aluminium vaporizes near this temperature. To overcome this, specific additives are mixed into the bath.

Step 3: Analyze the role of adding cryolite ( $\text{Na}_3\text{AlF}_6$ ) along with fluorspar ( $\text{CaF}_2$ ) to the purified alumina. Cryolite acts as a molten solvent that dissolves the alumina matrix.

Step 4: Evaluate the physical effect of this addition on the mixture. The addition of cryolite drops the melting point of the electrolyte blend significantly from 2323 K down to roughly 1223 K ( $950^\circ\text{C}$ ).

Step 5: Evaluate the effect on electrical behavior. Cryolite dissociates into ions in the liquid state, which drastically improves the overall electrical conductivity of the electrolytic melt, facilitating smooth electrolysis.

**Final Answer:**

Lower the melting point and increase the electrical conductivity of the melt

**Answer: (C)**[Go Back to Question 13](#)

Q14.

**Solution****Concept:**

Liquefied Petroleum Gas (LPG) is a commercial fuel mixture compiled of gaseous hydrocarbons that are compressed into a liquid state for storage and transport. It consists primarily of low molecular weight alkanes, which burn with a high calorific value and produce minimal residue.

**Solution:**

Step 1: Identify the typical hydrocarbon components that make up Liquefied Petroleum Gas. LPG is synthesized from natural gas processing and petroleum refining, yielding a blend of propane, butane, and small amounts of ethane.

Step 2: Determine the proportion of these constituents within standard domestic fuel cylinders. While propane ( $C_3H_8$ ) and butane ( $C_4H_{10}$ ) are both present, butane is the dominant component, making up over 60% of the mixture by volume under standard conditions.

Step 3: Note the specific structural isomers present. The butane portion consists of both normal butane (n-butane) and isobutane, with n-butane being the single largest constituent.

Step 4: Examine the given choices: Methane is the primary component of CNG and natural gas, whereas butane is the primary component of LPG.

Step 5: Conclude that butane is the primary constituent responsible for the performance of LPG as a domestic fuel.

**Final Answer:**

**Answer:** (C)

[Go Back to Question 14](#)



Q15.

**Solution****Concept:**

The acidity or alkalinity of an aqueous solution is governed by the self-ionization constant of water ( $K_w$ ). The pH value represents the negative logarithm of the hydrogen ion concentration, while the pOH represents the negative logarithm of the hydroxyl ion concentration. At 298 K, their sum always equals 14.

**Solution:**

Step 1: Identify the given hydrogen ion concentration from the problem statement:

$$[\text{H}^+] = 1 \times 10^{-4} \text{ mol/L}$$

Step 2: Compute the pH value of the solution using its mathematical definition:

$$\text{pH} = -\log_{10}[\text{H}^+] = -\log_{10}(10^{-4}) = -(-4) = 4$$

Step 3: Determine the nature of the solution based on the calculated pH. Since a pH of 4 is strictly less than 7, the solution is acidic in nature.

Step 4: Utilize the relationship connecting pH and pOH in aqueous systems at room temperature (25°C):

$$\text{pH} + \text{pOH} = 14$$

Step 5: Substitute the known value of pH into the equation to isolate and calculate pOH:

$$4 + \text{pOH} = 14 \implies \text{pOH} = 14 - 4 = 10$$

Step 6: Combine both findings. The nature of the solution is acidic, and its corresponding pOH value is 10.

**Final Answer:**

**Answer:**

[Go Back to Question 15](#)



Q16.

**Solution****Concept:**

Metal oxides are generally basic in nature and react with acids, while non-metal oxides are acidic and react with bases. However, certain metal oxides display dual chemical behavior by reacting with both strong acids and strong bases to produce salt and water; such oxides are classified as amphoteric.

**Solution:**

Step 1: Define the criteria for an amphoteric oxide. An oxide must be able to undergo chemical neutralization reactions with both acidic reagents and basic reagents.

Step 2: Evaluate Sodium Oxide ( $\text{Na}_2\text{O}$ ). Sodium is an alkali metal, and its oxide reacts vigorously with water to form a strong base ( $\text{NaOH}$ ). It is purely a basic oxide.

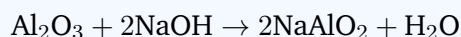
Step 3: Evaluate Sulphur Dioxide ( $\text{SO}_2$ ). Sulphur is a non-metal, and its oxide reacts with water to yield sulphurous acid ( $\text{H}_2\text{SO}_3$ ). It is strictly an acidic oxide.

Step 4: Evaluate Calcium Oxide ( $\text{CaO}$ ). Calcium is an alkaline earth metal, making its oxide purely basic.

Step 5: Evaluate Aluminium Oxide ( $\text{Al}_2\text{O}_3$ ). Aluminium lies on the border between metallic and non-metallic character. It reacts with hydrochloric acid to form aluminium chloride:



It also reacts with strong bases like sodium hydroxide to form sodium aluminate:



Step 6: Since  $\text{Al}_2\text{O}_3$  satisfies both conditions, it is classified as an amphoteric oxide.

**Final Answer:**

**Answer: (C)** [Go Back to Question 16](#)



Q17.

**Solution****Concept:**

Balancing a chemical equation requires satisfying the Law of Conservation of Mass, which dictates that the total number of atoms for each individual element must be identical on both the reactant and product sides of the equation.

**Solution:**

Step 1: Write down the unbalanced reaction expression provided in the prompt:



Step 2: Apply atom conservation starting with manganese (Mn). There is  $a$  atoms of Mn on the left and  $c$  atoms on the right. Setting  $a = 1$  gives:

$$c = 1$$

Step 3: Balance the oxygen (O) atoms based on the value assigned to  $a$ . The reactant side contains  $2a = 2(1) = 2$  oxygen atoms. The product side contains  $d$  oxygen atoms in the water molecules. Equating them gives:

$$d = 2$$

Step 4: Balance the hydrogen (H) atoms using the value found for  $d$ . The product side now contains  $2d = 2(2) = 4$  hydrogen atoms. These must originate from the HCl molecules on the reactant side, which has  $b$  hydrogen atoms:

$$b = 4$$

Step 5: Balance the chlorine (Cl) atoms to find the final coefficient  $e$ . The reactant side contains  $b = 4$  chlorine atoms. The product side contains chlorine in both  $\text{MnCl}_2$  and  $\text{Cl}_2$ :

$$\text{Total Reactant Cl} = \text{Product Cl} \implies 4 = 2c + 2e$$

Substitute  $c = 1$  into this expression:

$$4 = 2(1) + 2e \implies 4 = 2 + 2e \implies 2e = 2 \implies e = 1$$

Step 6: List the calculated set of coefficients:  $a = 1, b = 4, c = 1, d = 2, e = 1$ . The prompt requests the values of  $a, b$ , and  $d$ , which are 1, 4, and 2 respectively.

**Final Answer:**

**Answer: (A)**

[Go Back to Question 17](#)



Q18.

**Solution****Concept:**

A diagonal relationship is a unique periodic trend observed between certain elements of the second and third periods located diagonally adjacent to one another. This similarity arises due to a balancing of periodic trends, resulting in nearly identical ionic sizes and similar electronegativity or charge-to-size ratios (polarizing power).

**Solution:**

Step 1: Map the top-left section of the periodic table containing main-group elements from Periods 2 and 3:

- Period 2: Lithium (Li), Beryllium (Be), Boron (B), Carbon (C)
- Period 3: Sodium (Na), Magnesium (Mg), Aluminium (Al), Silicon (Si)

Step 2: Examine the general shifts in atomic and ionic radius across the table. Moving from left to right across a period causes the atomic radius to decrease. Conversely, moving down a group causes the atomic radius to increase.

Step 3: Analyze the combined effect of moving diagonally down and to the right. The decrease in size from moving right balances the increase in size from moving down, resulting in diagonally adjacent elements having very similar sizes and polarizing powers.

Step 4: Identify the classic diagonally related pairs established in chemistry:

- Lithium (Li) of Group 1 shows a diagonal relationship with Magnesium (Mg) of Group 2.
- Beryllium (Be) of Group 2 shows a diagonal relationship with Aluminium (Al) of Group 13.
- Boron (B) of Group 13 shows a diagonal relationship with Silicon (Si) of Group 14.

Step 5: Review the choices. Option A lists Lithium and Magnesium, which perfectly matches the first pair.

**Final Answer:**

[Go Back to Question 18](#)



Q19.

**Solution****Concept:**

Corrosion of iron is an electrochemical process commonly referred to as rusting. When elemental iron is exposed to both oxygen and moisture simultaneously, it undergoes a slow oxidation process that converts the metallic surface into a flaky, reddish-brown hydrated metal oxide.

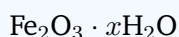
**Solution:**

Step 1: Analyze the environmental conditions required for rusting. The process requires iron (Fe), oxygen (O<sub>2</sub>), and water (H<sub>2</sub>O) to interact. Stripping away either air or moisture halts rust formation.

Step 2: Trace the chemical oxidation steps. Iron is first oxidized to iron(II) ions (Fe<sup>2+</sup>) at the anodic regions, which are further oxidized by atmospheric oxygen to form iron(III) ions (Fe<sup>3+</sup>).

Step 3: These iron(III) ions combine with hydroxide ions and water molecules to precipitate a hydrated oxide layer. The chemical formula representing this reddish-brown compound is hydrated iron(III) oxide.

Step 4: Express this composition as a chemical formula:



Here,  $x$  represents a variable number of water molecules of crystallization associated with the structural lattice.

Step 5: Compare this with the other options: Fe<sub>3</sub>O<sub>4</sub> is magnetic iron oxide (black), FeCO<sub>3</sub> is siderite, and Fe(OH)<sub>2</sub> is iron(II) hydroxide. The correct formula for rust is the hydrated oxide.

**Final Answer:**

**Answer: (B)**

[Go Back to Question 19](#)



Q20.

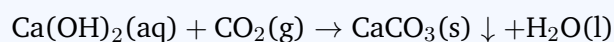
**Solution****Concept:**

The reaction of calcium compounds with carbon dioxide depends heavily on the concentration and duration of gas exposure. Lime water, an aqueous solution of calcium hydroxide, forms an insoluble compound with  $\text{CO}_2$  that can be converted into a soluble derivative upon further reaction with excess gas.

**Solution:**

Step 1: Write down the chemical formula for lime water, which is calcium hydroxide,  $\text{Ca(OH)}_2$ .

Step 2: Analyze what happens when carbon dioxide gas ( $\text{CO}_2$ ) is introduced for a short duration. A chemical reaction occurs, producing insoluble calcium carbonate and water:



The calcium carbonate forms a suspension of fine white particles, which turns the solution milky.

Step 3: Analyze the chemical changes that occur when excess carbon dioxide gas continues to bubble through this milky suspension.

Step 4: Formulate the chemical equation for this secondary reaction. The insoluble calcium carbonate reacts further with the additional  $\text{CO}_2$  and water to form calcium bicarbonate:



Step 5: Consider the physical properties of the new product. Calcium bicarbonate,  $\text{Ca(HCO}_3)_2$ , is highly soluble in water. As it forms and dissolves into the solution, the white precipitate disappears, clearing the milkiness.

**Final Answer:**

**Answer:** (C)

[Go Back to Question 20](#)



Q21.

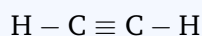
**Solution****Concept:**

The hybridisation state of a carbon atom within an organic molecule depends on its steric number, which is determined by counting the total number of  $\sigma$  (sigma) bonds and lone pairs surrounding the atom. Pi ( $\pi$ ) bonds formed by lateral atomic orbital overlap do not influence the hybridisation geometry.

**Solution:**

Step 1: Identify the given molecule as ethyne (commonly known as acetylene), which has the molecular formula  $C_2H_2$ .

Step 2: Draw the structural formula of ethyne to clearly show all the chemical bonds connecting the atoms:



Step 3: Analyze the types of bonds around a single carbon atom. Each carbon atom forms one single covalent bond with a hydrogen atom and one triple bond with the adjacent carbon atom.

Step 4: Count the number of sigma ( $\sigma$ ) and pi ( $\pi$ ) bonds. A single bond is a  $\sigma$  bond. A triple bond consists of exactly one strong  $\sigma$  bond and two weaker  $\pi$  bonds. Therefore, each carbon atom forms:

$$\text{Number of } \sigma \text{ bonds} = 1(\text{to H}) + 1(\text{to C}) = 2$$

$$\text{Number of } \pi \text{ bonds} = 2(\text{both within the triple bond})$$

Step 5: Calculate the steric number for the carbon atom. Since carbon has no lone pairs in this structure, the steric number equals the number of  $\sigma$  bonds:

$$\text{Steric Number} = 2 + 0 = 2$$

Step 6: Correlate the steric number with its corresponding hybridisation state. A steric number of 2 requires the mixing of one s orbital and one p orbital, resulting in sp hybridisation with a linear geometry ( $180^\circ$  bond angle).

Final Answer:

Answer: (C)

[Go Back to Question 21](#)



Q22.

**Solution****Concept:**

For a fixed mass of an ideal gas maintained at a constant temperature, the volume occupied by the gas is inversely proportional to its pressure. This fundamental gas behavior is described quantitatively by Boyle's Law.

**Solution:**

Step 1: State the mathematical formulation of Boyle's Law for comparing two states of a gas system:

$$P_1V_1 = P_2V_2$$

Step 2: Extract the initial and final parameters provided in the problem statement:

- Initial Pressure ( $P_1$ ) = 760 mm Hg
- Initial Volume ( $V_1$ ) = 400 mL
- Final Pressure ( $P_2$ ) = 950 mm Hg
- Final Volume ( $V_2$ ) = ?

Step 3: Rearrange the Boyle's Law equation to solve for the unknown final volume ( $V_2$ ):

$$V_2 = \frac{P_1V_1}{P_2}$$

Step 4: Substitute the known values into the rearranged equation:

$$V_2 = \frac{760 \times 400}{950}$$

Step 5: Perform the arithmetic simplification step-by-step. First, cancel out common factors in the terms:

$$V_2 = \frac{76 \times 400}{95} = \frac{30400}{95}$$

Step 6: Divide 30400 by 95 to determine the final numerical value:

$$V_2 = 320 \text{ mL}$$

Since the pressure increased, the volume decreased proportionally, as expected.

**Final Answer:**

**Answer: (A)** [Go Back to Question 22](#)



Q23.

### Solution

**Concept:**

A metal displacement reaction occurs when a more chemically reactive element displaces a less reactive metal from its aqueous salt solution. The relative reactivity of metals can be predicted using the standard electrochemical reactivity series.

**Solution:**

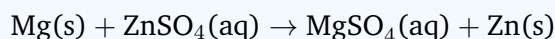
Step 1: Understand the core rule governing single displacement reactions: a metal can only displace another metal from its salt solution if it is positioned higher up in the reactivity series.

Step 2: Identify the target metal ion in solution, which is zinc (Zn). We need to find an element from the choices that is more reactive than zinc.

Step 3: Analyze the positions of the metals listed in the options relative to zinc in the reactivity series:

- Copper (Cu) is near the bottom, well below zinc. It is less reactive and cannot displace zinc.
- Iron (Fe) is also below zinc in the reactivity series, so it cannot displace zinc.
- Magnesium (Mg) is an alkaline earth metal situated significantly higher than zinc. It is more reactive.
- Lead (Pb) is located below iron and zinc, so it is less reactive.

Step 4: Write down the chemical equation demonstrating the displacement using the more reactive magnesium metal:



Step 5: Conclude that Magnesium is the only option capable of reducing zinc ions into elemental zinc.

**Final Answer:**

**Answer: (C)** [Go Back to Question 23](#)



Q24.

**Solution****Concept:**

Organic molecules are classified into families based on their functional groups, which dictate their chemical properties. The IUPAC name uses systematic suffixes to indicate the primary functional group present within the carbon skeleton.

**Solution:**

Step 1: Analyze the systematic IUPAC name of the given compound, which is propanone.

Step 2: Break down the name into its constituent parts to decode the structural features:

- The prefix "prop-" indicates a chain of three carbon atoms.
- The infix "-an-" indicates that the carbon-carbon bonds are single saturated bonds.
- The suffix "-one" is the specific functional suffix reserved for ketones.

Step 3: Recall the general structural formula for a ketone. A ketone contains a carbonyl group bonded to two carbon-containing alkyl groups, located inside the carbon chain:



Step 4: Draw out the structural formula of propanone (commonly known as acetone) to verify the linkage:



Step 5: Identify the central functional group. The characteristic group is the carbonyl group, represented as  $> C = O$ .

Step 6: Evaluate the other choices:  $-CHO$  is an aldehyde,  $-OH$  is an alcohol, and  $-COOH$  is a carboxylic acid. Therefore, option D is the correct choice.

Final Answer:  $> C = O$

Answer: (D) [Go Back to Question 24](#)



Q25.

**Solution****Concept:**

The physical constants of hydride compounds, such as boiling points, are strongly influenced by the strength of their intermolecular forces. Stronger intermolecular forces require more thermal energy to overcome, resulting in a higher boiling point.

**Solution:**

Step 1: Compare the boiling points of water ( $\text{H}_2\text{O}$ ) and hydrogen sulphide ( $\text{H}_2\text{S}$ ). Water is a liquid at room temperature with a high boiling point of  $100^\circ\text{C}$ , while  $\text{H}_2\text{S}$  is a gas that liquefies at a much lower temperature ( $-60^\circ\text{C}$ ).

Step 2: Analyze the composition of both molecules. Oxygen and sulphur both belong to Group 16. Since sulphur is heavier than oxygen,  $\text{H}_2\text{S}$  has stronger London dispersion forces. If dispersion forces were the only factor,  $\text{H}_2\text{S}$  would have a higher boiling point than water.

Step 3: Explain the anomalous behavior of water by looking at electronegativity. Oxygen has a very high electronegativity value (3.44), whereas sulphur has a much lower value (2.58).

Step 4: Consider the polarity of the bonds. The large electronegativity difference between oxygen and hydrogen creates highly polar O – H bonds. This places a large partial positive charge on the hydrogen atom and a large partial negative charge on the oxygen atom.

Step 5: Identify the strong intermolecular attraction that forms as a result. These highly polar molecules form strong hydrogen bonds between the hydrogen atom of one water molecule and the lone pair of the highly electronegativity oxygen atom on an adjacent molecule.

Step 6: Since  $\text{H}_2\text{S}$  molecules cannot form these strong hydrogen bonds due to the lower electronegativity of sulphur, it boils at a much lower temperature.

**Final Answer:**

**Answer: (B)**

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## Answer Key

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

