UNIQUE STUDY POINT

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Class: X	**Subject:** Science	**Session:** 2025-26
Chapter: 03 - Metals and Non-metals	**Time:** 1½ Hours	**Max. Marks:** 40

General Instructions:

1. All questions are compulsory.
2. This question paper contains 20 questions divided into five sections A, B, C, D and E.
3. Section A contains 10 MCQs of 1 mark each.
4. Section B contains 4 questions of 2 marks each.
5. Section C contains 3 questions of 3 marks each.
6. Section D contains 1 question of 5 marks.
7. Section E contains 2 Case Study Based questions of 4 marks each.

SECTION A - Multiple Choice Questions (1 mark each)

1. Which of the following is the most malleable metal?
(a) Silver
(b) Gold
(c) Platinum
(d) Copper

2. The only non-metal that is a liquid at room temperature is:
(a) Mercury
(b) Bromine
(c) Iodine
(d) Chlorine

3. Which allotrope of carbon is a good conductor of electricity?
(a) Diamond
(b) Graphite
(c) Fullerene
(d) Coal

4. The process of coating iron with molten zinc is called:
(a) Electroplating
(b) Galvanisation
(c) Anodising
(d) Tinning

5. Which of the following metals can displace hydrogen from dilute acids?
(a) Copper
(b) Silver
(c) Zinc
(d) Gold

6. In the electrolytic refining of copper, impure copper is made:
(a) Cathode
(b) Anode
(c) Electrolyte
(d) Container

7. Which of the following pairs of reactants will undergo displacement reaction?
(a) NaCl solution + Copper metal
(b) $MgCl_2$ solution + Aluminium metal
(c) $FeSO_4$ solution + Silver metal
(d) $AgNO_3$ solution + Copper metal

8. The green coating on copper vessels is due to the formation of:
(a) Copper oxide
(b) Copper sulphide
(c) Basic copper carbonate
(d) Copper hydroxide

9. Which metal has the lowest melting point among alkali metals?
(a) Lithium
(b) Sodium
(c) Potassium
(d) Caesium

10. An alloy of lead and tin is:
(a) Bronze
(b) Brass
(c) Solder
(d) Steel

SECTION B - Short Answer Questions (2 marks each)

11. What is meant by the term 'gangue'? How is it removed from the ore?

12. Explain why aluminium is a highly reactive metal yet it is used to make utensils for cooking.

13. Write two properties of ionic compounds.

14. What is meant by 22 carat gold? Why is pure gold not used for making jewelry?

SECTION C - Short Answer Questions (3 marks each)

15. Explain the formation of magnesium chloride ($MgCl_2$) by the transfer of electrons. Show the ions present in this compound.

16. What is electrolytic refining? Describe the process of electrolytic refining of copper with a labeled diagram.

17. Explain why:
(a) Platinum, gold and silver are used to make jewelry
(b) Sodium, potassium and lithium are stored under oil
(c) Carbonate and sulphide ores are converted into oxides during extraction

SECTION D - Long Answer Question (5 marks)

18. What is meant by the reactivity series of metals? Explain how it helps in predicting:

(a) The ability of metals to displace hydrogen from acids

(b) Displacement reactions between metals and their salt solutions

(c) The method of extraction of metals from their ores

Support your answer with suitable examples.

SECTION E - Case Study Based Questions (4 marks each)

19. Case Study 1:

A metallurgical company needs to extract zinc from zinc sulphide ore (ZnS). The extraction process involves several steps including enrichment of ore, conversion to oxide, reduction, and refining. The company uses carbon as a reducing agent and electrolytic refining for purification.

Based on this information, answer the following:

(a) Write the chemical equation for conversion of zinc sulphide to zinc oxide. Name this process. (2 marks)

(b) Write the equation for reduction of zinc oxide to zinc using carbon. (1 mark)

(c) Why is electrolytic refining necessary after extraction? (1 mark)

20. Case Study 2:

A student performed an experiment to test the conductivity of ionic compounds. She took samples of sodium chloride in three different states: solid crystals, molten (melted) state, and dissolved in water. She set up an electric circuit with a battery, bulb, and two electrodes for each sample and tested their ability to conduct electricity.

Answer the following questions based on the experiment:

(a) In which state(s) did the bulb glow? Explain your answer. (2 marks)

(b) Why do ionic compounds not conduct electricity in solid state? (1 mark)

(c) What happens to the ions when electricity is passed through molten sodium chloride? (1 mark)

DETAILED ANSWER KEY - PAPER 03

SECTION A - Answers to MCQs

1. (b) Gold

Gold is the most malleable metal. It can be beaten into extremely thin sheets called gold leaf.

2. (b) Bromine

Bromine is the only non-metal that exists as a liquid at room temperature. It is a reddish-brown liquid.

3. (b) Graphite

Graphite is an allotrope of carbon that conducts electricity due to the presence of free electrons in its structure.

4. (b) Galvanisation

Galvanisation is the process of coating iron or steel with a protective layer of zinc to prevent rusting.

5. (c) Zinc

Zinc is placed above hydrogen in the activity series and can displace hydrogen from dilute acids.

6. (b) Anode

In electrolytic refining of copper, impure copper is made the anode while a thin strip of pure copper is made the cathode.

7. (d) $AgNO_3$ solution + Copper metal

Copper is more reactive than silver and can displace it from silver nitrate solution.

8. (c) Basic copper carbonate

When copper reacts with moist carbon dioxide in air, it forms a green coating of basic copper carbonate.

9. (d) Caesium

Caesium has a very low melting point (about 28.5°C) and can melt if kept on palm.

10. (c) Solder

Solder is an alloy of lead and tin used for welding electrical wires due to its low melting point.

SECTION B - Answers to Short Answer Questions

11.

Gangue: Gangue refers to the impurities such as soil, sand, and other unwanted materials present in ores mined from the earth.

Removal of Gangue: The gangue is removed from the ore through a process called enrichment or concentration of ore. Different methods are used based on the physical or chemical properties of the ore and gangue, such as:

- Gravity separation
- Magnetic separation
- Froth flotation
- Chemical methods

12.

Aluminium is a highly reactive metal, yet it is used to make cooking utensils because:

When aluminium is exposed to air, it develops a thin layer of aluminium oxide (Al_2O_3) on its surface. This oxide layer is very stable and protective. It prevents the metal from further oxidation and corrosion.

This protective oxide coating makes aluminium resistant to corrosion and safe for use in cooking. Additionally, aluminium is a good conductor of heat, light in weight, and does not react with food, making it ideal for utensils.

13.

Two properties of ionic compounds:

1. High Melting and Boiling Points: Ionic compounds have high melting and boiling points because of the strong electrostatic forces of attraction between oppositely charged ions. A large amount of energy is required to break these forces.

2. Electrical Conductivity: Ionic compounds conduct electricity in molten state or when dissolved in water because ions are free to move. However, they do not conduct electricity in solid state as ions are held in fixed positions.

14.

22 Carat Gold: 22 carat gold means that 22 parts out of 24 parts are pure gold, and the remaining 2 parts consist of other metals like copper or silver. It represents the purity of gold in terms of 24 parts.

Why pure gold (24 carat) is not used for jewelry:
Pure gold is extremely soft and can be easily bent, scratched, or deformed. It is not suitable for making jewelry as ornaments need to be durable and maintain their shape. Therefore, gold is alloyed with small amounts of copper or silver to make it harder and more suitable for jewelry making.

SECTION C - Answers to Short Answer Questions

15.

Formation of Magnesium Chloride ($MgCl_2$):

Magnesium (Mg) has atomic number 12 with electronic configuration 2,8,2
Chlorine (Cl) has atomic number 17 with electronic configuration 2,8,7

Transfer of electrons:

Magnesium atom: Has 2 electrons in its outermost shell. It loses 2 electrons to achieve stable configuration of 2,8
Mg (2,8,2) → Mg^{2+} (2,8) + $2e^-$
(Forms magnesium cation with +2 charge)

Chlorine atom: Has 7 electrons in its outermost shell. Each chlorine atom gains 1 electron to achieve stable configuration of 2,8,8
Cl (2,8,7) + e^- → Cl^- (2,8,8)
(Forms chloride anion with -1 charge)

Since magnesium loses 2 electrons and each chlorine gains 1 electron, two chlorine atoms are needed:
$2Cl + 2e^- \rightarrow 2Cl^-$

The oppositely charged ions attract each other:
$Mg^{2+} + 2Cl^- \rightarrow MgCl_2$

Ions present in $MgCl_2$:
• Magnesium cation (Mg^{2+})

• Chloride anions (Cl^-) - two chloride ions for each magnesium ion

16.

Electrolytic Refining:
Electrolytic refining is a process of purifying impure metals using electrolysis. It is the most widely used method for refining metals like copper, zinc, tin, nickel, silver, and gold.

Process of Electrolytic Refining of Copper:

Setup:
• **Anode:** Impure copper (to be refined)
• **Cathode:** Thin strip of pure copper
• **Electrolyte:** Solution of acidified copper sulphate ($CuSO_4$)

Process:
When electric current is passed through the electrolyte:

At Anode (Impure copper):
$Cu \rightarrow Cu^{2+} + 2e^-$
Copper from the impure anode dissolves into the electrolyte as copper ions (Cu^{2+})

At Cathode (Pure copper):
$Cu^{2+} + 2e^- \rightarrow Cu$
Pure copper from the electrolyte gets deposited on the cathode

Impurities:
• Soluble impurities remain in the solution
• Insoluble impurities settle at the bottom of the anode as anode mud

Result: Pure copper is obtained at the cathode while impurities are left behind.

17.

(a) Platinum, gold and silver are used to make jewelry because:
• They are very less reactive or unreactive metals
• They do not corrode or tarnish easily
• They retain their luster and shine for long periods
• They are malleable and can be shaped into beautiful designs
• They are precious and valuable

(b) Sodium, potassium and lithium are stored under oil because:
• These are highly reactive alkali metals
• They react vigorously with oxygen and moisture in air
• They can catch fire if kept in open air
• Storing them under kerosene oil prevents their contact with air and moisture
• This ensures safety and prevents accidental fires

(c) Carbonate and sulphide ores are converted into oxides during extraction because:
• It is easier to obtain metals from their oxides compared to carbonates and sulphides
• Metal oxides can be easily reduced to metals using suitable reducing agents like carbon
• The conversion processes (calcination for carbonates and roasting for sulphides) help remove unwanted non-metallic elements
• This simplifies the reduction process and makes extraction more efficient

SECTION D - Answer to Long Answer Question

18.

Reactivity Series of Metals:
The reactivity series is a list of metals arranged in order of their decreasing reactivity. It is based on the observations of displacement reactions and reactions with water, oxygen, and acids.

Order of Reactivity Series:
K > Na > Ca > Mg > Al > Zn > Fe > Pb > [H] > Cu > Hg > Ag > Au
(Most reactive to least reactive)

(a) Predicting displacement of hydrogen from acids:

Metals placed above hydrogen in the reactivity series can displace hydrogen from dilute acids, while metals below hydrogen cannot.

Example 1: Zinc can displace hydrogen from dilute acids
$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
(Zinc is above hydrogen in the series)

Example 2: Copper cannot displace hydrogen from dilute acids
$Cu(s) + HCl(aq) \rightarrow$ No reaction
(Copper is below hydrogen in the series)

(b) Predicting displacement reactions between metals and salt solutions:

A more reactive metal (higher in the series) can displace a less reactive metal (lower in the series) from its salt solution.

Example 1: Iron displaces copper from copper sulphate
$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$
(Iron is more reactive than copper)

Example 2: Copper cannot displace zinc
$Cu(s) + ZnSO_4(aq) \rightarrow$ No reaction
(Copper is less reactive than zinc)

(c) Predicting method of extraction of metals from ores:

The position of a metal in the reactivity series determines the method used for its extraction:

1. Highly reactive metals (K, Na, Ca, Mg, Al):
• Cannot be reduced by carbon
• Extracted by electrolytic reduction of their molten compounds
• Example: Sodium is extracted by electrolysis of molten NaCl

2. Moderately reactive metals (Zn, Fe, Pb):
• Can be reduced by carbon
• Extracted by heating their oxides with carbon
• Example: $ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$

3. Less reactive metals (Cu, Hg, Ag, Au):
• Low reactivity
• Some found in free state (Au, Ag)
• Can be extracted by simple heating or mild reducing agents
• Example: $2HgO(s) \rightarrow 2Hg(l) + O_2(g)$

Thus, the reactivity series is a powerful tool for predicting and understanding various chemical reactions involving

metals.

SECTION E - Answers to Case Study Based Questions

19.

(a) The chemical equation for conversion of zinc sulphide to zinc oxide is:

$2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$

Name of the process: This process is called **ROASTING**.

Roasting is the process of heating sulphide ores strongly in the presence of excess air to convert them into oxides. The sulphur in the ore is oxidized to sulphur dioxide gas, which escapes, leaving behind the metal oxide.

(b) The equation for reduction of zinc oxide to zinc using carbon is:

$ZnO(s) + C(s) \rightarrow Zn(s) + CO(g)$

In this reaction, carbon acts as a reducing agent. It removes oxygen from zinc oxide, reducing it to metallic zinc. Carbon itself gets oxidized to carbon monoxide.

(c) Electrolytic refining is necessary after extraction because:

The zinc obtained by reduction contains impurities from the ore and the reducing agent. Electrolytic refining is used to obtain pure zinc by removing these impurities. In this process, impure zinc is made the anode and pure zinc is deposited at the cathode, while impurities either dissolve in the electrolyte or settle as anode mud. This ensures high purity of the final metal product, which is essential for industrial and commercial applications.

20.

(a) The bulb glowed in two states:

1. Molten (melted) sodium chloride: The bulb glowed because when NaCl is heated to molten state, the strong electrostatic forces holding the ions in fixed positions are overcome. The Na^+ and Cl^- ions become free to move. When electricity is passed, these mobile ions move towards opposite electrodes and conduct electricity, making the bulb glow.

2. Sodium chloride dissolved in water: The bulb glowed because when NaCl dissolves in water, it dissociates into Na^+ and Cl^- ions. These ions are free to move in the solution and can conduct electricity by moving to opposite electrodes, completing the circuit and lighting the bulb.

The bulb did NOT glow with solid sodium chloride crystals because ions are held in fixed positions and cannot move to conduct electricity.

(b) Ionic compounds do not conduct electricity in solid state because:

In the solid state, the positive and negative ions are held together in a rigid crystal lattice structure by strong electrostatic forces of attraction. The ions are in fixed positions and cannot move freely. Since electrical conductivity requires the movement of charged particles, and the ions cannot move in solid state, ionic compounds do not conduct electricity when solid.

(c) When electricity is passed through molten sodium chloride:

At Cathode (negative electrode):
$Na^+ + e^- \rightarrow Na$
Sodium ions (Na^+) move towards the cathode, gain electrons, and are reduced to sodium metal.

At Anode (positive electrode):
$2Cl^- \rightarrow Cl_2 + 2e^-$
Chloride ions (Cl^-) move towards the anode, lose electrons, and are oxidized to chlorine gas.

Thus, sodium metal is deposited at the cathode and chlorine gas is liberated at the anode. This is how sodium metal is extracted commercially.
