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 property allows metals to be beaten into thin sheets?
(a) Ductility
(b) Malleability
(c) Sonority
(d) Conductivity

2. Which metal is protected from corrosion by a layer of its own oxide?
(a) Iron
(b) Copper
(c) Aluminium
(d) Zinc

3. The hardest natural substance known is:
(a) Graphite
(b) Iron
(c) Diamond
(d) Platinum

4. Which of the following oxide is neutral?
(a) CO_2
(b) SO_2
(c) N_2O
(d) MgO

5. When magnesium ribbon burns in air, the flame produced is:
(a) Blue
(b) Yellow
(c) Dazzling white
(d) Green

6. An ore from which mercury is extracted is:
(a) Bauxite
(b) Cinnabar
(c) Haematite
(d) Calamine

7. Stainless steel is an alloy of:
(a) Iron, carbon and chromium
(b) Iron, nickel and chromium
(c) Iron, carbon, nickel and chromium
(d) Iron, zinc and copper

8. The reaction of iron(III) oxide with aluminium is known as:
(a) Combination reaction
(b) Decomposition reaction
(c) Displacement reaction
(d) Double displacement reaction

9. Which metal does not react with water even as steam?
(a) Aluminium
(b) Zinc
(c) Copper
(d) Iron

10. The chemical formula of rust is:
(a) Fe_2O_3
(b) FeO
(c) Fe_3O_4
(d) $Fe_2O_3.xH_2O$

SECTION B - Short Answer Questions (2 marks each)

11. Why are metals good conductors of heat and electricity?

12. What is the difference between calcination and roasting? Give one example of each.

13. Explain why sodium metal is stored under kerosene oil but not under water.

14. Write two methods to prevent rusting of iron.

SECTION C - Short Answer Questions (3 marks each)

15. Describe an activity to show that metals are good conductors of heat. Draw a labeled diagram.

16. What are the advantages of using alloys over pure metals? Give three examples of commonly used alloys with their composition and uses.

17. Explain the extraction of copper from copper(I) sulphide ore (Cu_2S). Write the chemical equations involved in the process.

SECTION D - Long Answer Question (5 marks)

18. Describe the chemical properties of metals with respect to their reaction with:
(a) Oxygen
(b) Water

(c) Dilute acids

(d) Salt solutions of other metals

Support your answer with appropriate chemical equations.

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

19. Case Study 1:

An ancient iron pillar near the Qutub Minar in Delhi was built more than 1600 years ago. The pillar is 8 meters high and weighs 6 tonnes (6000 kg). Despite being exposed to the elements for over 16 centuries, it has not rusted significantly. Scientists from around the world have examined this pillar to understand the rust-resistant properties developed by ancient Indian metallurgists.

Based on this case study, answer the following:

(a) What are the two essential conditions required for iron to rust? (1 mark)

(b) Why is the Delhi Iron Pillar scientifically significant? (1 mark)

(c) Suggest two modern methods that can be used to prevent rusting of iron structures. (2 marks)

20. Case Study 2:

A chemistry student conducted a series of experiments to study the reactivity of metals. She took four metals P, Q, R, and S and performed the following tests:

Test 1: When heated in air, metals P and Q burned vigorously, metal R formed a black coating, and metal S did not react.

Test 2: Metals P and Q reacted violently with cold water, metal R did not react with cold water but reacted with steam, and metal S did not react even with steam.

Test 3: All metals except S reacted with dilute hydrochloric acid to produce hydrogen gas.

Based on these observations, answer the following:

(a) Identify the most reactive and least reactive metals among P, Q, R, and S. (1 mark)

(b) Write the chemical equation for the reaction of metal R with steam. (Assume R is a metal like iron or zinc) (1 mark)

(c) Arrange metals P, Q, R, and S in order of decreasing reactivity. Explain how you arrived at this order. (2 marks)

DETAILED ANSWER KEY - PAPER 04

SECTION A - Answers to MCQs

1. (b) Malleability

Malleability is the property of metals that allows them to be beaten into thin sheets without breaking.

2. (c) Aluminium

Aluminium develops a thin protective layer of aluminium oxide (Al_2O_3) when exposed to air, which prevents further corrosion.

3. (c) Diamond

Diamond, an allotrope of carbon, is the hardest natural substance known with very high melting and boiling points.

4. (c) N_2O

Nitrous oxide (N_2O) is a neutral oxide. It does not react with acids or bases.

5. (c) Dazzling white

When magnesium ribbon burns in air, it produces a dazzling white flame and forms magnesium oxide.

6. (b) Cinnabar

Cinnabar (HgS) is the main ore of mercury. When heated, it converts to mercuric oxide and then to mercury.

7. (c) Iron, carbon, nickel and chromium

Stainless steel is an alloy of iron mixed with carbon, nickel, and chromium. It is hard and does not rust.

8. (c) Displacement reaction

The thermit reaction (Fe_2O_3 + Al) is a displacement reaction where aluminium displaces iron from its oxide.

9. (c) Copper

Copper does not react with water in any form - neither cold water, hot water, nor steam.

10. (d) $Fe_2O_3.xH_2O$

Rust is hydrated iron(III) oxide represented as $Fe_2O_3.xH_2O$, where x represents variable amount of water.

SECTION B - Answers to Short Answer Questions

11.

Metals are good conductors of heat and electricity because of the presence of free electrons in their structure.

Heat conduction: When one part of a metal is heated, the free electrons gain kinetic energy and move rapidly throughout the metal, transferring heat energy quickly from the hot part to the cooler parts.

Electrical conduction: When an electric potential is applied across a metal, the free electrons move from the negative terminal to the positive terminal, creating an electric current. This movement of electrons allows metals to conduct electricity efficiently.

12.

Calcination:

• Process of heating carbonate ores strongly in limited or absence of air
• Used to convert carbonate ores into oxides
• Example: $ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g)$

Roasting:
• Process of heating sulphide ores strongly in the presence of excess air
• Used to convert sulphide ores into oxides
• Example: $2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$

13.

Sodium metal is stored under kerosene oil but not under water because:

Sodium is an extremely reactive metal that reacts very vigorously with water. The reaction is highly exothermic and produces sodium hydroxide and hydrogen gas:
$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g) + Heat$

The heat produced is so much that the hydrogen gas evolved catches fire, which can cause explosion. Therefore, sodium cannot be stored in water.

Kerosene oil does not react with sodium and prevents its contact with air and moisture, making it a safe storage medium.

14.

Two methods to prevent rusting of iron:

1. Galvanisation: Coating iron with a thin layer of zinc. The zinc layer protects iron from rusting even if the coating is broken because zinc is more reactive than iron and prevents oxygen from reaching the iron surface.

2. Painting or Oiling: Applying paint or oil on iron surfaces creates a protective barrier that prevents air and moisture from coming in contact with iron, thus preventing rust formation.

Other methods include: Greasing, Chrome plating, Anodising, or making alloys like stainless steel.

SECTION C - Answers to Short Answer Questions

15.

Activity to show that metals are good conductors of heat:

Materials required: Aluminium or copper wire, stand with clamp, wax, pin, burner/spirit lamp

Procedure:
1. Take an aluminium or copper wire and clamp it on a stand horizontally
2. Fix a pin to the free end of the wire using wax
3. Heat the wire with a burner near the place where it is clamped
4. Observe what happens after some time

Observation:
After some time, the wax at the free end of the wire melts and the pin falls down.

Conclusion:
The heat is conducted from the heated end to the other end of the metal wire, causing the wax to melt. This proves that metals are good conductors of heat.

Labeled Diagram:
[The diagram should show: Stand with clamp holding metal wire horizontally, burner heating one end, wax and pin

attached to free end, with labels for Stand, Clamp, Metal wire, Burner, Wax, Pin, and Free end of wire]

16.

Advantages of using alloys over pure metals:

1. Alloys are generally harder and stronger than pure metals
2. Alloys have different and often more useful properties than the constituent metals
3. Alloys can be designed to have specific properties like corrosion resistance, lower melting point, etc.
4. Alloys are often more durable and suitable for specific applications

Examples of commonly used alloys:

1. Brass:
• Composition: Copper (Cu) + Zinc (Zn)
• Uses: Making utensils, decorative items, musical instruments, door handles
• Properties: Hard, corrosion-resistant, golden appearance

2. Bronze:
• Composition: Copper (Cu) + Tin (Sn)
• Uses: Making statues, medals, coins, bells
• Properties: Hard, resists corrosion, good casting properties

3. Stainless Steel:
• Composition: Iron (Fe) + Carbon (C) + Nickel (Ni) + Chromium (Cr)
• Uses: Making cutlery, kitchen sinks, surgical instruments
• Properties: Hard, does not rust, resistant to corrosion

4. Solder:
• Composition: Lead (Pb) + Tin (Sn)
• Uses: Welding electrical wires together
• Properties: Low melting point, good electrical conductor

17.

Extraction of Copper from Copper(I) Sulphide (Cu_2S):

Copper is found in nature as Cu_2S. It can be obtained from its ore by just heating in air without using any reducing agent.

Step 1: Roasting in Air
When copper(I) sulphide is heated in air, it is partially oxidized to copper(I) oxide:
$2Cu_2S(s) + 3O_2(g) \rightarrow 2Cu_2O(s) + 2SO_2(g)$

Step 2: Reduction
When the mixture of Cu_2S and Cu_2O is further heated in absence of air, the remaining Cu_2S reduces Cu_2O to give copper metal:
$2Cu_2O(s) + Cu_2S(s) \rightarrow 6Cu(s) + SO_2(g)$

Alternatively, the overall reaction can be shown as:
$Cu_2S(s) + O_2(g) \rightarrow 2Cu(s) + SO_2(g)$

Note: In this process, no external reducing agent like carbon is needed. The ore itself acts as a reducing agent. The impure copper obtained is then purified by electrolytic refining to get pure copper.

SECTION D - Answer to Long Answer Question

18.

Chemical Properties of Metals:

(a) Reaction with Oxygen:

Almost all metals combine with oxygen to form metal oxides. Most metal oxides are basic in nature.
Metal + Oxygen → Metal Oxide

Examples:
1. Copper forms copper(II) oxide:
$2Cu(s) + O_2(g) \rightarrow 2CuO(s)$
(Black oxide)

2. Aluminium forms aluminium oxide:
$4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$

3. Magnesium burns with dazzling white flame:
$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

Reactivity varies: Potassium and sodium react so vigorously that they catch fire and are kept in kerosene. Silver and gold do not react with oxygen even at high temperatures.

Some metal oxides are amphoteric (react with both acids and bases):
$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$ (acidic behavior)
$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$ (basic behavior)

(b) Reaction with Water:

Metals react with water to produce metal oxide/hydroxide and hydrogen gas:
Metal + Water → Metal Oxide/Hydroxide + Hydrogen

With Cold Water (Highly reactive metals):
1. Sodium reacts violently:
$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g) + Heat$
The reaction is so exothermic that hydrogen catches fire

2. Calcium reacts less violently:
$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$
Calcium floats due to hydrogen bubbles

With Hot Water (Moderately reactive):
Magnesium reacts with hot water:
$Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g)$

With Steam (Less reactive):
1. Iron with steam:
$3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$

2. Zinc with steam:
$Zn(s) + H_2O(g) \rightarrow ZnO(s) + H_2(g)$

Metals like copper, silver, and gold do not react with water at all.

(c) Reaction with Dilute Acids:

Metals react with dilute acids to produce salt and hydrogen gas:

Metal + Dilute Acid → Salt + Hydrogen gas

Examples:
1. Magnesium with hydrochloric acid:
$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

2. Aluminium with sulphuric acid:
$2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

3. Zinc with hydrochloric acid:
$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

4. Iron with sulphuric acid:
$Fe(s) + H_2SO_4(aq) \rightarrow FeSO_4(aq) + H_2(g)$

Only metals above hydrogen in the reactivity series can displace hydrogen from acids. Copper, silver, and gold do not react with dilute acids.

Note: Hydrogen gas is NOT evolved when metals react with nitric acid (HNO_3) because it is a strong oxidizing agent and oxidizes H_2 to water.

(d) Reaction with Salt Solutions of Other Metals:

A more reactive metal can displace a less reactive metal from its salt solution:
Metal A + Salt solution of B → Salt solution of A + Metal B
(More reactive) (Less reactive)

Examples:
1. Iron displaces copper from copper sulphate:
$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$
(Brown coating of copper appears on iron nail)

2. Zinc displaces copper from copper sulphate:
$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

3. Copper displaces silver from silver nitrate:
$Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

4. No reaction occurs when less reactive metal is used:
$Cu(s) + ZnSO_4(aq) \rightarrow$ No reaction
(Copper cannot displace zinc as it is less reactive)

These displacement reactions help in determining the reactivity series of metals and are used to predict whether a reaction will occur or not.

SECTION E - Answers to Case Study Based Questions

19.

(a) The two essential conditions required for iron to rust are:
1. Presence of moisture (water)
2. Presence of oxygen (air)
Both conditions must be present simultaneously for rusting to occur.

(b) The Delhi Iron Pillar is scientifically significant because:
It demonstrates the advanced metallurgical knowledge of ancient Indian craftsmen who developed a process that prevented iron from rusting. Despite being exposed to the elements for over 1600 years, the pillar has not rusted

significantly. Scientists from around the world have studied this pillar to understand the rust-resistant properties. This shows that ancient Indians had developed superior techniques for metal treatment and protection that modern science is still trying to fully understand and replicate.

(c) Two modern methods to prevent rusting of iron structures:

1. Galvanisation: Coating iron or steel with a thin layer of zinc. The zinc layer acts as a protective barrier and prevents moisture and oxygen from reaching the iron surface. Even if the zinc coating is broken, the iron remains protected because zinc is more reactive than iron and preferentially oxidizes, protecting the iron beneath (sacrificial protection).

2. Painting: Applying layers of paint on iron surfaces creates a protective coating that prevents air and moisture from coming in direct contact with the iron. This is commonly used for iron gates, railings, bridges, and other structures. The paint must be maintained and reapplied periodically for continued protection.

Other methods include: Chrome plating, powder coating, using corrosion-resistant alloys like stainless steel, or applying oil/grease (though this is temporary and mainly used for tools and machinery).

20.

(a) Based on the observations:
Most reactive metals: P and Q (both react violently with cold water)
Least reactive metal: S (does not react with air, water, steam, or dilute acid)

Between P and Q, both are highly reactive (likely sodium/potassium group). Metal R is moderately reactive (like iron/zinc/aluminium), and metal S is least reactive (like copper/silver/gold).

(b) Assuming metal R is zinc or iron (metals that react with steam):

If R is Zinc:
$Zn(s) + H_2O(g) \rightarrow ZnO(s) + H_2(g)$

If R is Iron:
$3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$

In both cases, the metal reacts with steam to form metal oxide and hydrogen gas.

(c) Order of decreasing reactivity: **P ≈ Q > R > S**

Explanation of how this order was determined:

Test 1 (Reaction with air/oxygen):
• P and Q burned vigorously → Very reactive
• R formed black coating → Moderately reactive (forms oxide layer)
• S did not react → Least reactive

Test 2 (Reaction with water):
• P and Q reacted violently with cold water → Most reactive (like Na, K, Ca)
• R reacted only with steam, not cold water → Moderately reactive (like Zn, Fe, Al)
• S did not react even with steam → Least reactive (like Cu, Ag, Au)

Test 3 (Reaction with dilute acids):
• P, Q, and R reacted with dilute HCl → Above hydrogen in activity series
• S did not react with dilute acid → Below hydrogen in activity series

Conclusion:
Combining all three tests:

- P and Q are highly reactive metals (possibly sodium and potassium)
- R is moderately reactive (possibly zinc, iron, or aluminium)
- S is least reactive (possibly copper, silver, or gold)

This order matches the Activity Series of metals: K > Na > Ca > Mg > Al > Zn > Fe > Pb > [H] > Cu > Hg > Ag > Au

The tests show that reactivity decreases from left to right, with P and Q being most reactive, followed by R, and S being least reactive.
