

A. Physical Properties of Metals and Non-Metals

Metals:

- Luster: Metals have shiny surfaces when freshly cut (except sodium and potassium which tarnish quickly)
- Malleability: Can be hammered into thin sheets (gold most malleable)
- Ductility: Can be drawn into wires (gold most ductile)
- Conductivity: Good conductors of heat and electricity (silver best conductor)
- State: All solid at room temperature except mercury (liquid)
- Sonority: Produce ringing sound when struck (sonorous)

Non-Metals:

- Generally dull appearance (except iodine and diamond which are lustrous)
- Brittle in solid state (cannot be hammered or drawn)
- Poor conductors of heat and electricity (except graphite)
- Exist in all three states: solids (carbon, sulfur), liquid (bromine), gases (oxygen, nitrogen)
- Not sonorous

B. Chemical Properties

1. Reaction with Oxygen:

- Metals form basic oxides:
 $4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}$ (sodium oxide - basic)
 $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ (magnesium oxide - basic)
- Some metals form amphoteric oxides (react with both acids and bases):
 $\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2\text{O}$
 $\text{Al}_2\text{O}_3 + 2\text{NaOH} \rightarrow 2\text{NaAlO}_2 + \text{H}_2\text{O}$ (sodium aluminate)
- Non-metals form acidic or neutral oxides:
 $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$ (acidic oxide)
 $\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}$ (neutral oxide)

2. Reaction with Water:

- Highly reactive metals (K, Na, Ca) react with cold water:
 $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2 \uparrow$
- Moderately reactive metals (Mg, Al, Zn, Fe) react with steam:
 $3\text{Fe} + 4\text{H}_2\text{O} (\text{steam}) \rightarrow \text{Fe}_3\text{O}_4 + 4\text{H}_2 \uparrow$
- Less reactive metals (Cu, Ag, Au) do not react with water

3. Reaction with Acids:

- Metals above hydrogen in reactivity series displace hydrogen from acids:
$$\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2 \uparrow$$
- Metals below hydrogen (Cu, Ag, Au) do not react with dilute acids
- Nitric acid (HNO_3) is exception - doesn't produce H_2 with most metals due to its oxidizing nature

4. Reaction with Chlorine:

- Both metals and non-metals form chlorides:



5. Displacement Reactions:

- More reactive metal displaces less reactive metal from its salt solution:



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- Reactivity series determines displacement capability

C. Reactivity Series of Metals

The reactivity series arranges metals in decreasing order of reactivity

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Most Reactive → Least Reactive:

Potassium (K) > Sodium (Na) > Calcium (Ca) > Magnesium (Mg) > Aluminium (Al) > (Carbon) > Zinc (Zn) > Iron (Fe) > Tin (Sn) > Lead (Pb) > (Hydrogen) > Copper (Cu) > Silver (Ag) > Gold (Au) > Platinum (Pt)

Significance:

- Predicts displacement reactions
- Determines method of extraction from ores
- Explains corrosion tendencies

D. Ionic Compounds

Formation:

- Formed by transfer of electrons from metal to non-metal
- Metal loses electrons → forms cation (+ve ion)
- Non-metal gains electrons → forms anion (-ve ion)
- Electrostatic attraction binds ions together

Properties:

- High melting and boiling points due to strong ionic bonds
- Soluble in water but insoluble in organic solvents
- Conduct electricity in molten state or aqueous solution (ions free to move) but not in solid state
- Crystalline solids at room temperature
- Generally brittle

E. Occurrence of Metals

- Native/Free State: Least reactive metals (Au, Ag, Pt) found as elements
- Combined State: Most metals occur as minerals/ores:
 - Oxides (bauxite $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$, haematite Fe_2O_3)
 - Carbonates (limestone CaCO_3 , calamine ZnCO_3)
 - Sulphides (zinc blende ZnS , galena PbS)
 - Chlorides (rock salt NaCl)

Mineral vs Ore:

All ores are minerals, but not all minerals are ores. A mineral becomes an ore when metal can be extracted profitably

F. Metallurgy (Extraction of Metals)

Three Main Steps:

1. Concentration of Ore (Enrichment):
 - Hydraulic washing (gravity separation)
 - Froth flotation (for sulphide ores)
 - Magnetic separation (for magnetic ores)
2. Conversion to Metal:
 - Roasting: Heating sulphide ore in excess air $\rightarrow$ oxide
$$2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$$
 - Calcination: Heating carbonate/hydrated ore in limited air $\rightarrow$ oxide
$$\text{ZnCO}_3 \rightarrow \text{ZnO} + \text{CO}_2$$
 - Reduction: Converting metal oxide to metal:
 - Highly reactive metals (K, Na, Ca, Mg, Al): Electrolytic reduction
 - Moderately reactive (Zn, Fe, Sn, Pb): Reduction with carbon/carbon monoxide
 - Less reactive (Cu, Ag, Au): Heating alone or simple reduction
3. Refining: Purification of crude metal (electrolytic refining for Cu, Ag, Au)

G. Corrosion and Prevention

Corrosion: Gradual destruction of metals by reaction with environment (air, moisture)

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Rusting of Iron:



Prevention Methods:

1. Painting/Oiling/Greasing: Creates barrier against air and moisture
2. Galvanization: Coating iron with zinc layer; zinc acts as sacrificial anode
3. Chrome Plating: Electroplating with chromium
4. Anodizing: Thickening oxide layer on aluminium
5. Alloying: Making alloys resistant to corrosion (stainless steel)

H. Alloys

Definition: Homogeneous mixture of two or more metals, or a metal and non-metal

Important Alloys:

- Brass: Cu + Zn (used in musical instruments, decorative items)
- Bronze: Cu + Sn (used in statues, medals)
- Solder: Pb + Sn (low melting point, used for welding)
- Stainless Steel: Fe + Cr + Ni + C (corrosion resistant, used in utensils)
- Duralumin: Al + Cu + Mg + Mn (lightweight, used in aircraft)

Advantages of Alloys:

- Increased hardness and strength
- Lower melting points (useful for soldering)
- Enhanced corrosion resistance
- Improved appearance

1. Which of the following metals exists in liquid state at room temperature?

- (a) Sodium
- (b) Potassium
- (c) Mercury
- (d) Gallium

✓ Answer: (c) Mercury

💡 Explanation: Mercury (Hg) is the only metal that remains liquid at room temperature (melting point = -39°C). Gallium melts at 30°C (just above room temperature).

 Concept: Physical properties of metals

2. The property of metals that allows them to be drawn into wires is called:

- (a) Malleability
- (b) Ductility
- (c) Sonority
- (d) Conductivity

 Answer: (b) Ductility

 Explanation: Ductility is the ability to be drawn into thin wires. Gold is the most ductile metal (1 gram can be drawn into 2 km wire).

 Concept: Physical properties of metals

3. Which non-metal is lustrous?

- (a) Sulphur
- (b) Phosphorus
- (c) Iodine
- (d) Oxygen

 Answer: (c) Iodine

 Explanation: Iodine crystals have a shiny, metallic lustre despite being a non-metal. Diamond (carbon allotrope) is also lustrous.

 Concept: Physical properties of non-metals

4. An amphoteric oxide is one that:

- (a) Reacts only with acids
- (b) Reacts only with bases
- (c) Reacts with both acids and bases
- (d) Does not react with acids or bases

 Answer: (c) Reacts with both acids and bases

💡 Explanation: Amphoteric oxides show dual behaviour. Example: $\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2\text{O}$ and $\text{Al}_2\text{O}_3 + 2\text{NaOH} \rightarrow 2\text{NaAlO}_2 + \text{H}_2\text{O}$

📖 Concept: Chemical properties – reaction with oxygen

5. Which metal does NOT react with cold water but reacts with steam?

- (a) Sodium
- (b) Potassium
- (c) Calcium
- (d) Iron

✅ Answer: (d) Iron

💡 Explanation: Highly reactive metals (Na, K, Ca) react with cold water. Moderately reactive metals (Mg, Al, Zn, Fe) react only with steam: $3\text{Fe} + 4\text{H}_2\text{O}(\text{steam}) \rightarrow \text{Fe}_3\text{O}_4 + 4\text{H}_2\uparrow$

📖 Concept: Reaction of metals with water

6. The reactivity series arranges metals in order of decreasing:

- (a) Density
- (b) Melting point
- (c) Tendency to lose electrons
- (d) Atomic mass

✅ Answer: (c) Tendency to lose electrons

💡 Explanation: Reactivity depends on ease of electron loss (ionization). More reactive metals lose electrons more readily to form cations.

📖 Concept: Reactivity series fundamentals

7. Which metal is stored under kerosene oil?

- (a) Iron
- (b) Copper
- (c) Sodium
- (d) Zinc

✔ Answer: (c) Sodium

💡 Explanation: Sodium reacts violently with atmospheric moisture and oxygen. Kerosene prevents contact with air/water.

📖 Concept: Storage of reactive metals

8. When zinc is added to copper sulphate solution, the colour change observed is:

- (a) Blue to green
- (b) Blue to colourless
- (c) Green to blue
- (d) No change

✔ Answer: (b) Blue to colourless

💡 Explanation: $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$. Blue Cu^{2+} ions are replaced by colourless Zn^{2+} ions. Red-brown copper deposits on zinc surface.

📖 Concept: Displacement reactions

9. Which of the following is a poor conductor of electricity?

- (a) Graphite
- (b) Copper
- (c) Sulphur
- (d) Aluminium

✔ Answer: (c) Sulphur

💡 Explanation: Sulphur is a non-metal and lacks free electrons/mobile ions for conduction. Graphite (carbon allotrope) is an exception among non-metals.

📖 Concept: Electrical conductivity

10. The process of heating an ore strongly in limited supply of air is called:

- (a) Roasting
- (b) Calcination
- (c) Smelting

(d) Refining

✓ Answer: (b) Calcination

💡 Explanation: Calcination converts carbonate/hydrated ores to oxides: $\text{ZnCO}_3 \rightarrow \text{ZnO} + \text{CO}_2$. Roasting (excess air) is for sulphide ores.

📖 Concept: Metallurgy – concentration & conversion

11. Which alloy contains copper and zinc?

(a) Bronze

(b) Brass

(c) Solder

(d) Stainless steel

✓ Answer: (b) Brass

💡 Explanation: Brass = Cu (70%) + Zn (30%). Used in musical instruments, decorative items. Bronze = Cu + Sn.

📖 Concept: Alloys and their composition

12. Ionic compounds conduct electricity in molten state because:

(a) They decompose into elements

(b) Ions become free to move

(c) Electrons are released

(d) Heat energy breaks covalent bonds

✓ Answer: (b) Ions become free to move

💡 Explanation: In solid state, ions are fixed in lattice. On melting/dissolving, ions gain mobility and carry electric current.

📖 Concept: Properties of ionic compounds

13. The green coating formed on copper vessels exposed to moist air is due to formation of:

(a) Copper oxide

(b) Copper carbonate

(c) Copper sulphate

(d) Copper chloride

✅ Answer: (b) Copper carbonate

💡 Explanation: $2\text{Cu} + \text{H}_2\text{O} + \text{CO}_2 + \text{O}_2 \rightarrow \text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$ (basic copper carbonate – green patina).

📖 Concept: Corrosion of metals

14. Which metal is extracted by electrolytic reduction?

(a) Iron

(b) Zinc

(c) Aluminium

(d) Copper

✅ Answer: (c) Aluminium

💡 Explanation: Highly reactive metals (K, Na, Ca, Mg, Al) are extracted by electrolysis of molten salts because carbon cannot reduce their oxides.

📖 Concept: Extraction based on reactivity series

15. Galvanization is a method of protecting iron from rusting by coating it with:

(a) Chromium

(b) Tin

(c) Zinc

(d) Nickel

✅ Answer: (c) Zinc

💡 Explanation: Zinc forms a protective layer and acts as sacrificial anode – it oxidizes first, protecting iron even if coating is scratched.

📖 Concept: Corrosion prevention

16. Which non-metal is essential for respiration?

(a) Carbon

(b) Nitrogen

(c) Oxygen

(d) Sulphur

✅ Answer: (c) Oxygen

💡 Explanation: Oxygen is required for cellular respiration: $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{energy}$.

📖 Concept: Biological importance of non-metals

17. The ore of aluminium is:

(a) Haematite

(b) Bauxite

(c) Calamine

(d) Galena

✅ Answer: (b) Bauxite

💡 Explanation: Bauxite = $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ (hydrated aluminium oxide). Haematite (Fe_2O_3) is iron ore; Calamine (ZnCO_3) is zinc ore.

📖 Concept: Important ores

18. Which of the following oxides is acidic?

(a) Na_2O

(b) MgO

(c) CO_2

(d) CaO

✅ Answer: (c) CO_2

💡 Explanation: Non-metal oxides are generally acidic: $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3$ (carbonic acid). Metal oxides (Na_2O , MgO , CaO) are basic.

📖 Concept: Nature of oxides

19. Anodising is done to protect:

- (a) Iron
- (b) Copper
- (c) Aluminium
- (d) Zinc

✓ Answer: (c) Aluminium

💡 Explanation: Anodising thickens the natural oxide layer on aluminium by electrolysis, making it corrosion-resistant and dye-absorbent.

📖 Concept: Corrosion prevention methods

20. Which metal is the best conductor of heat?

- (a) Copper
- (b) Aluminium
- (c) Silver
- (d) Gold

✓ Answer: (c) Silver

💡 Explanation: Silver has highest thermal conductivity among metals due to maximum free electron density.

📖 Concept: Physical properties of metals

21. The reaction: $\text{Fe}_2\text{O}_3 + 2\text{Al} \rightarrow \text{Al}_2\text{O}_3 + 2\text{Fe}$ is an example of:

- (a) Combination reaction
- (b) Decomposition reaction
- (c) Displacement reaction
- (d) Double displacement reaction

✓ Answer: (c) Displacement reaction

💡 Explanation: Aluminium (more reactive) displaces iron from its oxide. This is the thermite reaction used for welding railway tracks.

📖 Concept: Reactivity series applications

22. Which of the following is NOT a property of ionic compounds?

- (a) High melting point
- (b) Soluble in water
- (c) Conduct electricity in solid state
- (d) Crystalline solids

✔ Answer: (c) Conduct electricity in solid state

💡 Explanation: Ionic compounds conduct only in molten/aqueous state when ions are mobile. Solid state ions are fixed in lattice.

📖 Concept: Properties of ionic compounds

23. The process of purifying impure metal after extraction is called:

- (a) Roasting
- (b) Calcination
- (c) Refining
- (d) Smelting

✔ Answer: (c) Refining

💡 Explanation: Electrolytic refining purifies metals like Cu, Ag, Au. Impure metal = anode; pure metal deposits on cathode.

📖 Concept: Metallurgy steps

24. Which gas is evolved when dilute HCl reacts with zinc?

- (a) Oxygen
- (b) Carbon dioxide
- (c) Hydrogen
- (d) Chlorine

✔ Answer: (c) Hydrogen

💡 Explanation: $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2\uparrow$. Metals above hydrogen in reactivity series displace H_2 from acids.

 Concept: Reaction of metals with acids

25. Brass is an alloy of:

- (a) Cu and Sn
- (b) Cu and Zn
- (c) Fe and C
- (d) Pb and Sn

 Answer: (b) Cu and Zn

 Explanation: Brass = Copper (70%) + Zinc (30%). Bronze = Cu + Sn; Steel = Fe + C; Solder = Pb + Sn.

 Concept: Alloys composition

26. Which metal forms a protective oxide layer that prevents further corrosion?

- (a) Iron
- (b) Copper
- (c) Aluminium
- (d) Zinc

 Answer: (c) Aluminium

 Explanation: Aluminium forms thin, adherent Al_2O_3 layer that prevents further oxidation – making it corrosion-resistant despite high reactivity.

 Concept: Corrosion behaviour

27. The metal that can be cut with a knife is:

- (a) Iron
- (b) Copper
- (c) Sodium
- (d) Zinc

 Answer: (c) Sodium

💡 Explanation: Sodium and potassium are soft metals due to weak metallic bonding and large atomic size.

📖 Concept: Physical properties of metals

28. Which of the following is a metalloid?

- (a) Silicon
- (b) Sulphur
- (c) Phosphorus
- (d) Chlorine

✅ Answer: (a) Silicon

💡 Explanation: Metalloids (Si, Ge, As, Sb, Te) show properties intermediate between metals and non-metals. Silicon is semiconductor.

📖 Concept: Classification of elements

29. The reaction of non-metals with oxygen generally produces:

- (a) Basic oxides
- (b) Amphoteric oxides
- (c) Acidic oxides
- (d) Neutral oxides only

✅ Answer: (c) Acidic oxides

💡 Explanation: Non-metal oxides dissolve in water to form acids: $\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3$ (sulphurous acid). Exceptions: CO, NO are neutral.

📖 Concept: Chemical properties of non-metals

30. Which method is used to concentrate sulphide ores?

- (a) Hydraulic washing
- (b) Magnetic separation
- (c) Froth flotation
- (d) Leaching

✅ Answer: (c) Froth flotation

💡 Explanation: Sulphide ore particles attach to oil froth and float, while gangue sinks. Used for ZnS (zinc blende), PbS (galena).

📖 Concept: Ore concentration methods

31. The most abundant metal in earth's crust is:

- (a) Iron
- (b) Aluminium
- (c) Calcium
- (d) Sodium

✅ Answer: (b) Aluminium

💡 Explanation: Aluminium constitutes ~8% of earth's crust by mass. Oxygen (non-metal) is most abundant element overall (~46%).

📖 Concept: Occurrence of metals

32. Which metal does NOT react with dilute hydrochloric acid?

- (a) Zinc
- (b) Iron
- (c) Copper
- (d) Magnesium

✅ Answer: (c) Copper

💡 Explanation: Copper lies below hydrogen in reactivity series and cannot displace H_2 from acids.

📖 Concept: Reactivity series applications

33. Stainless steel contains iron along with:

- (a) Cu and Zn
- (b) Cr and Ni
- (c) Sn and Pb

(d) Al and Mg

✓ Answer: (b) Cr and Ni

💡 Explanation: Stainless steel = Fe (73%) + Cr (18%) + Ni (8%) + C (1%). Chromium forms protective oxide layer preventing rusting.

📖 Concept: Alloys and their uses

34. The process of coating iron with tin is called:

(a) Galvanization

(b) Tinning

(c) Anodising

(d) Electroplating

✓ Answer: (b) Tinning

💡 Explanation: Tinning protects iron from rusting. Used for food cans. If tin layer breaks, iron rusts faster (tin is less reactive).

📖 Concept: Corrosion prevention

35. Which of the following is NOT a characteristic of non-metals?

(a) Low density

(b) Low melting point

(c) Malleability

(d) Poor conductivity

✓ Answer: (c) Malleability

💡 Explanation: Non-metals are brittle in solid state and cannot be hammered into sheets (non-malleable).

📖 Concept: Physical properties comparison

36. The reaction: $2\text{AgBr} \rightarrow 2\text{Ag} + \text{Br}_2$ occurs in presence of:

(a) Heat

(b) Electricity

(c) Light

(d) Catalyst

✅ Answer: (c) Light

💡 Explanation: Silver bromide decomposes photochemically – used in black & white photography.

📖 Concept: Chemical properties of silver compounds

37. Which metal is used in thermometers?

(a) Gallium

(b) Caesium

(c) Mercury

(d) Sodium

✅ Answer: (c) Mercury

💡 Explanation: Mercury's uniform expansion, high boiling point (357°C) and visibility make it suitable for thermometers.

📖 Concept: Applications of metals

38. The process of reduction involves:

(a) Loss of oxygen

(b) Gain of oxygen

(c) Loss of hydrogen

(d) Gain of electrons

✅ Answer: (d) Gain of electrons

💡 Explanation: Reduction = gain of electrons OR loss of oxygen. In metallurgy, metal oxides gain electrons (from C/CO) to form metals.

📖 Concept: Redox in metallurgy

39. Which non-metal is used in water purification?

(a) Sulphur

(b) Phosphorus

(c) Chlorine

(d) Nitrogen

✅ Answer: (c) Chlorine

💡 Explanation: Chlorine kills bacteria and pathogens in water treatment plants (chlorination).

📖 Concept: Uses of non-metals

40. The compound formed when sodium reacts with chlorine is:

(a) Covalent

(b) Ionic

(c) Metallic

(d) Coordinate

✅ Answer: (b) Ionic

💡 Explanation: Na (metal) transfers electron to Cl (non-metal) forming Na^+Cl^- – ionic compound with high melting point.

📖 Concept: Formation of ionic compounds

41. Which of the following metals catches fire on reaction with water?

(a) Magnesium

(b) Calcium

(c) Sodium

(d) Aluminium

✅ Answer: (c) Sodium

💡 Explanation: $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2\uparrow + \text{Heat}$. Reaction is highly exothermic; H_2 ignites with flame.

📖 Concept: Reaction of metals with water

42. The colour of copper sulphate solution is:

- (a) Green
- (b) Yellow
- (c) Blue
- (d) Colourless

✓ Answer: (c) Blue

💡 Explanation: Hydrated Cu^{2+} ions $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ impart blue colour to solution.

📖 Concept: Identification of metal salts

43. Which alloy has a low melting point and is used for soldering electrical wires?

- (a) Brass
- (b) Bronze
- (c) Solder
- (d) Duralumin

✓ Answer: (c) Solder

💡 Explanation: Solder = Pb (50%) + Sn (50%). Melts at $\sim 180^\circ\text{C}$ – ideal for joining electrical components without damaging them.

📖 Concept: Alloys and applications

44. The process of converting sulphide ore into oxide by heating in excess air is:

- (a) Calcination
- (b) Roasting
- (c) Smelting
- (d) Refining

✓ Answer: (b) Roasting

💡 Explanation: $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$. Roasting removes volatile impurities as gases (SO_2).

📖 Concept: Metallurgy conversion steps

45. Which metal is present in haemoglobin?

- (a) Copper
- (b) Iron
- (c) Zinc
- (d) Magnesium

✓ Answer: (b) Iron

💡 Explanation: Iron in haemoglobin binds with oxygen for transport in blood. Deficiency causes anaemia.

📖 Concept: Biological importance of metals

46. The gas produced when metal carbonates react with acids is:

- (a) Hydrogen
- (b) Oxygen
- (c) Carbon dioxide
- (d) Chlorine

✓ Answer: (c) Carbon dioxide

💡 Explanation: $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2\uparrow$. Effervescence of CO_2 is test for carbonate ion.

📖 Concept: Reaction of carbonates with acids

47. Which of the following is a displacement reaction?

- (a) $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$
- (b) $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$
- (c) $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$
- (d) $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$

✓ Answer: (c) $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$

💡 Explanation: More reactive zinc displaces less reactive copper from its salt solution.

📖 Concept: Displacement reactions

48. The metal used to make aircraft bodies is:

- (a) Iron
- (b) Copper
- (c) Aluminium
- (d) Lead

✅ Answer: (c) Aluminium

💡 Explanation: Aluminium alloys (duralumin) are lightweight, strong and corrosion-resistant – ideal for aircraft construction.

📖 Concept: Applications of metals/alloys

49. Which non-metal is stored under water?

- (a) Sulphur
- (b) Phosphorus
- (c) Iodine
- (d) Carbon

✅ Answer: (b) Phosphorus

💡 Explanation: White phosphorus ignites spontaneously in air (40°C). Stored under water to prevent contact with oxygen.

📖 Concept: Storage of reactive non-metals

50. The brown gas evolved during roasting of sulphide ores is:

- (a) CO_2
- (b) SO_2
- (c) NO_2
- (d) Cl_2

✅ Answer: (b) SO_2

💡 Explanation: Sulphide ores release sulphur dioxide during roasting: $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$ (pungent gas).

 Concept: Metallurgy environmental aspects

 HOW TO USE THIS RESOURCE EFFECTIVELY:

Purpose

Strategy

Daily Practice

Solve 10 MCQs daily with timer (1 min/question)

Concept Revision

After each MCQ, read the explanation thoroughly

Weak Areas

Note questions answered incorrectly → Revise that concept

Exam Simulation

Solve all 50 in 50 minutes (actual board exam pace)

Group Study

Discuss explanations with peers for deeper understanding

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Q1. Why do ionic compounds have high melting points? Explain with reference to their structure.

Answer:

Ionic compounds consist of positively charged cations and negatively charged anions held together by strong electrostatic forces of attraction in a rigid crystal lattice structure. Breaking this lattice requires large amount of energy to overcome these strong forces, resulting in high melting points (typically 300–1000°C).

Example: NaCl melts at 801°C.

 NCERT Reference: Page 49, Section 3.4 "Properties of Ionic Compounds", Para 1 (Explanation of strong forces in ionic solids)

Q2. Differentiate between mineral and ore with suitable examples.

Answer:

Mineral

Ore

Naturally occurring substance containing metal in combined state

Mineral from which metal can be profitably and conveniently extracted

All ores are minerals but not all minerals are ores

Must be economically viable for extraction

Example: Clay contains aluminium but extraction is costly

Example: Bauxite ($\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$) is ore of aluminium

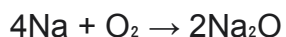
 NCERT Reference: Page 52, Section 3.5 "Occurrence of Metals", Para 2 (Definition of ore vs mineral)

Q3. Why is sodium kept immersed in kerosene oil?

Answer:

Sodium is highly reactive metal that:

(i) Reacts vigorously with atmospheric oxygen $\rightarrow$ forms sodium oxide



(ii) Reacts violently with moisture $\rightarrow$ forms sodium hydroxide + hydrogen (which may catch fire)



Kerosene oil prevents contact with air and moisture, ensuring safe storage.

 NCERT Reference: Page 44, Section 3.3.1 "Reaction with Oxygen", Activity 3.11 observation note

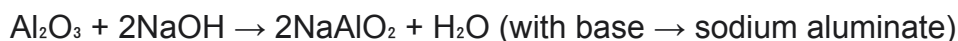
Q4. What is an amphoteric oxide? Give two examples with chemical equations.

Answer:

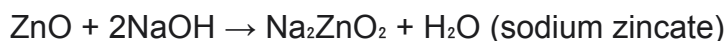
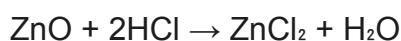
Amphoteric oxides react both with acids and bases to form salt and water.

Examples:

(i) Aluminium oxide:



(ii) Zinc oxide:

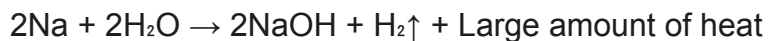


 NCERT Reference: Page 46, Section 3.3.1, Para after Activity 3.13 (Amphoteric nature of Al_2O_3 and ZnO)

Q5. Why do metals like potassium and sodium catch fire when treated with water?

Answer:

Potassium and sodium are extremely reactive metals (top of reactivity series). Their reaction with water is highly exothermic:



The heat produced is sufficient to ignite the hydrogen gas evolved, causing fire/flame. Potassium reacts even more violently than sodium.

 NCERT Reference: Page 45, Section 3.3.2 "Reaction with Water", Para 2 (Explanation of vigorous reaction)

Q6. Name the process used for enrichment of sulphide ores. Explain the principle involved.

Answer:

Froth flotation process is used for sulphide ore enrichment.

Principle:

Sulphide ore particles are wetted by oil (pine oil) while gangue (earthly impurities) is wetted by water.

Air is blown creating froth; ore particles attach to oil froth and float on surface.

Gangue particles sink to bottom.

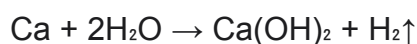
Froth is skimmed off to obtain concentrated ore.

 NCERT Reference: Page 53, Section 3.5.1 "Enrichment of Ores", Para 3 (Froth flotation description)

Q7. Why does calcium float on water during its reaction with water?

Answer:

Calcium reacts moderately with cold water:



The hydrogen gas bubbles formed during reaction stick to the surface of calcium metal, reducing its effective density and causing it to float on water surface.

 NCERT Reference: Page 45, Section 3.3.2, Activity 3.14 observation (Calcium floats due to H₂ bubbles)

Q8. What is galvanization? How does it prevent rusting of iron?

Answer:

Galvanization is the process of applying a protective zinc coating on iron/steel articles by dipping them in molten zinc.

Protection mechanism:

- (i) Zinc forms a physical barrier preventing contact with air/moisture
- (ii) Zinc is more reactive than iron → acts as sacrificial anode
- (iii) Even if coating is scratched, zinc oxidizes first: $2\text{Zn} + \text{O}_2 \rightarrow 2\text{ZnO}$, protecting underlying iron

 NCERT Reference: Page 57, Section 3.7 "Corrosion", Para 4 (Galvanization explanation)

Q9. Why are ionic compounds soluble in water but insoluble in organic solvents like kerosene?

Answer:

Water is a polar solvent with partial positive (H) and negative (O) charges. These polar water molecules surround ions (hydration):

Positive ends surround anions

Negative ends surround cations

This hydration overcomes ionic bonds → dissolution occurs.

Organic solvents (kerosene, petrol) are non-polar and cannot solvate ions → no dissolution.

 NCERT Reference: Page 49, Section 3.4, Para 2 (Solubility of ionic compounds)

Q10. What is an alloy? Give two reasons why alloys are preferred over pure metals.

Answer:

Alloy is a homogeneous mixture of two or more metals, or a metal and a non-metal.

Advantages over pure metals:

(i) Increased hardness & strength – Pure metals are soft due to regular atomic arrangement; alloying distorts lattice making deformation difficult

(ii) Lower melting point – Useful for applications like soldering (solder melts at 180°C vs pure Pb 327°C, Sn 232°C)

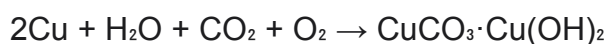
Additional: Better corrosion resistance (stainless steel vs iron)

 NCERT Reference: Page 56, Section 3.6 "Alloys", Para 1 (Definition and advantages)

Q11. Why does copper vessel develop a green coating when exposed to moist air for long time?

Answer:

Copper reacts slowly with atmospheric CO₂, moisture and oxygen to form basic copper carbonate:



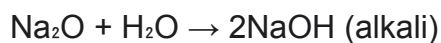
This compound is green in colour and forms a coating called patina. It protects underlying copper from further corrosion (unlike rust on iron).

 NCERT Reference: Page 46, Section 3.3.3 "Reaction with Acids", footnote after Activity 3.15 (Green coating on copper)

Q12. Explain why metal oxides are generally basic while non-metal oxides are acidic in nature.

Answer:

Metal oxides: Metals lose electrons to form cations. Their oxides react with water to produce OH^- ions $\rightarrow$ basic nature



Non-metal oxides: Non-metals gain electrons to form anions. Their oxides react with water to produce H^+ ions $\rightarrow$ acidic nature



Exception: Amphoteric oxides (Al_2O_3 , ZnO) and neutral oxides (CO , NO)

 NCERT Reference: Page 44, Section 3.3.1, Activity 3.12 & 3.13 observations (Nature of oxides)

Q13. What is calcination? Give chemical equation for calcination of zinc carbonate ore.

Answer:

Calcination is the process of heating carbonate or hydrated ores strongly in limited supply of air to convert them into metal oxides. Volatile impurities are removed.

Equation for calamine (ZnCO_3):



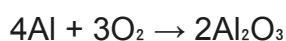
(Heated to $\sim 1000^\circ\text{C}$)

 NCERT Reference: Page 54, Section 3.5.2 "Extracting Metals Low in Reactivity Series", Para 2 (Calcination definition)

Q14. Why does aluminium not corrode easily despite being highly reactive?

Answer:

Aluminium reacts rapidly with atmospheric oxygen to form a thin, adherent layer of Al_2O_3 on its surface:



This oxide layer:

- (i) Is impervious to air/moisture
- (ii) Strongly adheres to metal surface (doesn't flake off)

(iii) Prevents further oxidation of underlying metal

Thus, aluminium appears unreactive despite high position in reactivity series.

 NCERT Reference: Page 56, Section 3.6 "Alloys", Para 3 (Aluminium's protective oxide layer)

Q15. What happens when iron nails are placed in copper sulphate solution? Write balanced equation and observation.

Answer:

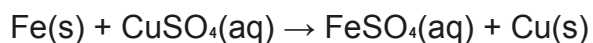
Observation:

Blue colour of CuSO_4 solution fades gradually

Brownish-red deposit of copper forms on iron nails

Solution turns green due to formation of FeSO_4

Chemical equation:



(Displacement reaction – iron being more reactive displaces copper)

 NCERT Reference: Page 47, Section 3.3.4 "Reaction with Solutions of Other Metal Salts", Activity 3.16

Q16. Why is graphite (non-metal) a good conductor of electricity while diamond is not?

Answer:

Graphite:

Has layered structure with weak van der Waals forces between layers

Each carbon atom is sp^2 hybridized $\rightarrow$ one free electron per atom delocalized in layers

These mobile electrons conduct electricity

Diamond:

Each carbon atom is sp^3 hybridized $\rightarrow$ tetrahedral network with all 4 valence electrons involved in covalent bonds

No free electrons $\rightarrow$ poor conductor

 NCERT Reference: Page 42, Section 3.2 "Physical Properties of Non-metals", Table 3.2 footnote (Graphite conductivity)

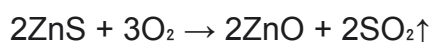
Q17. What is roasting? Why is it done for sulphide ores?

Answer:

Roasting is heating sulphide ores strongly in excess of air to convert them into metal oxides.

Purpose:

(i) Converts sulphide to oxide suitable for reduction:



(ii) Removes volatile impurities (S, As, Sb) as their oxides

(iii) SO_2 gas produced can be used to manufacture sulphuric acid (economic benefit)

 NCERT Reference: Page 54, Section 3.5.2, Para 1 (Roasting definition and purpose)

Q18. Why do ionic compounds conduct electricity in molten state but not in solid state?

Answer:

Solid state: Ions are fixed in rigid crystal lattice $\rightarrow$ no mobility $\rightarrow$ cannot conduct electricity

Molten/aqueous state:

Heat/water breaks ionic bonds

Ions become free to move

Mobile ions carry electric current when potential difference applied

Note: Conductivity increases with temperature in molten state (increased ion mobility)

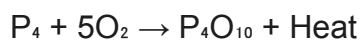
 NCERT Reference: Page 49, Section 3.4, Para 3 (Electrical conductivity of ionic compounds)

Q19. Name the metal stored under water. Why is it stored this way?

Answer:

Phosphorus (non-metal) is stored under water.

Reason: White phosphorus has very low ignition temperature (35°C) and catches fire spontaneously on exposure to atmospheric oxygen:



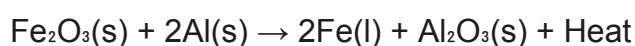
Water prevents contact with air, avoiding spontaneous combustion.

 NCERT Reference: Page 43, Section 3.2, Activity 3.6 observation note (Phosphorus storage)

Q20. What is the thermite reaction? Give its application.

Answer:

Thermite reaction is highly exothermic displacement reaction where aluminium reduces iron oxide:



(Reaction reaches ~2500°C)

Application:

Welding railway tracks – Molten iron fills gaps between rails

Used in incendiary devices and metal cutting

 NCERT Reference: Page 48, Section 3.3.4, Box item after Activity 3.17 (Thermite reaction)

 PART 2: 20 LONG ANSWER QUESTIONS (5 Marks Each)

Original questions created for educational purposes – NOT copied from CBSE papers

****Q1.** (a) Arrange the following metals in decreasing order of reactivity: Zn, Fe, Cu, Ag, Mg

(b) Explain displacement reaction with two examples.

(c) Why can't copper displace zinc from zinc sulphate solution? **

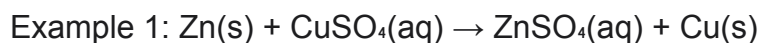
Answer:

(a) Reactivity order (decreasing):

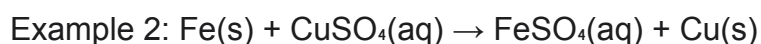


(Based on ease of electron loss – Mg loses electrons most readily)

(b) Displacement reaction: A more reactive metal displaces a less reactive metal from its salt solution.



(Zinc displaces copper – blue to colourless solution + brown deposit)



(Iron displaces copper – blue to green solution + brown deposit)

(c) Reason: Copper lies below zinc in reactivity series → copper is less reactive than zinc → cannot lose electrons more readily than zinc → cannot reduce Zn^{2+} ions to Zn metal. Only more reactive metals can displace less reactive ones.

 NCERT Reference: Page 47-48, Section 3.3.4 "Reaction with Solutions of Other Metal Salts"; Page 48, Table 3.4 (Reactivity series)

Q2. Explain the process of electrolytic refining of copper with a labelled diagram. Mention the reactions occurring at anode and cathode.

Answer:

Process: Impure copper (blister copper ~98% pure) is refined electrolytically to obtain 99.95% pure copper.

Setup:

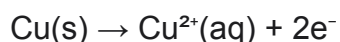
Anode: Thick block of impure copper

Cathode: Thin strip of pure copper

Electrolyte: Acidified copper sulphate solution ($\text{CuSO}_4 + \text{H}_2\text{SO}_4$)

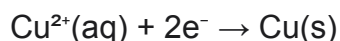
Reactions:

At Anode (Oxidation):



(Impure copper dissolves; impurities like Fe, Zn also dissolve but Au, Ag, Pt settle as anode mud)

At Cathode (Reduction):



(Pure copper deposits on cathode)

Anode mud: Contains precious metals (Au, Ag) recovered commercially.

Diagram description:

[Rectangular tank with electrolyte]

↑ Anode (Impure Cu) | Cathode (Pure Cu) ↓

Electrons flow: Anode → Battery → Cathode

Cu^{2+} ions move toward cathode; SO_4^{2-} move toward anode

Significance: Removes impurities (Fe, Zn, Ni, Ag, Au) to obtain high-purity copper for electrical wiring.

 NCERT Reference: Page 56, Section 3.5.3 "Refining of Metals", Fig. 3.14
(Electrolytic refining of copper)

Q3. Describe the extraction of iron from its ore haematite. Include: (a) Concentration method (b) Chemical reactions in blast furnace (c) Role of limestone

Answer:

Ore: Haematite (Fe_2O_3) – oxide ore

(a) Concentration:

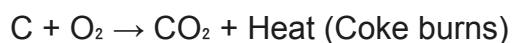
Hydraulic washing (gravity separation) used

Ore crushed → washed with high-pressure water stream

Lighter gangue particles washed away; heavier ore particles settle

(b) Blast furnace reactions (1500°C):

Zone 1 (Bottom – Combustion zone):



Zone 2 (Middle – Reduction zone):



Zone 3 (Top – Preheating zone):

Ore preheated by rising hot gases

(c) Role of limestone (CaCO_3):

Added as flux to remove silica (SiO_2) gangue

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

CaO reacts with SiO_2 : $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$ (slag)

Molten slag (calcium silicate) floats on molten iron $\rightarrow$ tapped separately

Slag used in cement/construction

Product: Molten iron (pig iron) containing 3-4% carbon + impurities $\rightarrow$ further processed to steel.

 NCERT Reference: Page 55, Section 3.5.2 "Extracting Metals in the Middle of Reactivity Series" (General process); Concept extended from Zn extraction principles

****Q4.** (a) What is corrosion? Write chemical equation for rusting of iron.

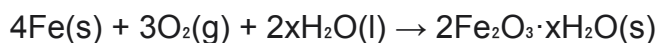
(b) List four methods to prevent rusting of iron with one example each.

(c) Why does aluminium not corrode like iron despite being more reactive? ******

Answer:

(a) Corrosion: Gradual deterioration/destruction of metals by reaction with environment (air, moisture, acids).

Rusting of iron (specific corrosion):



(Hydrated iron(III) oxide – reddish-brown flaky substance)

Conditions required: Both oxygen AND water/moisture must be present.

(b) Prevention methods:

Method

Principle

Example

Painting

Barrier protection

Bridges, ships painted

Galvanization

Sacrificial protection (Zn coating)

Iron buckets, roofing sheets

Oiling/Greasing

Barrier against moisture

Machine parts, tools

Alloying

Forms corrosion-resistant alloy

Stainless steel (cutlery)

(c) Aluminium vs Iron corrosion:

Aluminium forms thin, adherent Al_2O_3 layer that prevents further oxidation

Iron rust ($\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$) is porous and flaky $\rightarrow$ exposes fresh surface $\rightarrow$ continuous corrosion

Aluminium oxide layer is self-repairing if scratched; rust accelerates corrosion

 NCERT Reference: Page 56-57, Section 3.7 "Corrosion"; Page 56, Para 3 (Aluminium's protective layer)

Q5. Explain the formation of sodium chloride (NaCl) by electron transfer. Draw electron dot structures. Why does NaCl have high melting point?

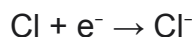
Answer:

Electron transfer process:

Sodium (Na, atomic no. 11): Electronic configuration 2,8,1 $\rightarrow$ loses 1 electron to achieve stable octet $\rightarrow$ forms Na^+



Chlorine (Cl, atomic no. 17): Electronic configuration 2,8,7 → gains 1 electron to achieve stable octet → forms Cl^-



Electron dot structures:

12

(Sodium atom donates electron to chlorine atom)

Crystal formation:

Na^+ and Cl^- ions arrange in alternating 3D lattice held by strong electrostatic forces → crystalline solid.

High melting point reason:

Breaking the strong electrostatic forces between oppositely charged ions in the rigid lattice requires large energy → NaCl melts at 801°C .

 NCERT Reference: Page 49, Section 3.4 "Properties of Ionic Compounds", Fig. 3.10 (Formation of NaCl)

****Q6.** (a) What is an alloy? Why are alloys stronger than pure metals?

(b) Give composition, properties and two uses each of: (i) Brass (ii) Bronze (iii) Solder**

Answer:

(a) Alloy definition: Homogeneous mixture of two or more metals, or a metal and non-metal.

Why alloys are stronger:

Pure metals have regular arrangement of atoms → layers slide easily over each other (soft)

Alloying introduces atoms of different sizes → distorts crystal lattice → prevents layer sliding → increased hardness/strength

Example: Pure gold (24 carat) too soft for jewellery → alloyed with Cu/Ag (22 carat) for strength

(b) Important alloys:

Alloy

Composition

Properties

Uses

Brass

Cu (70%) + Zn (30%)

Malleable, corrosion-resistant, gold-like appearance

Musical instruments, decorative items, cartridges

Bronze

Cu (90%) + Sn (10%)

Harder than brass, corrosion-resistant

Statues, medals, bearings

Solder

Pb (50%) + Sn (50%)

Low melting point ($\sim 180^{\circ}\text{C}$)

Joining electrical wires, plumbing

 NCERT Reference: Page 56, Section 3.6 "Alloys", Table 3.5 (Composition of important alloys)

Q7. Describe the extraction of aluminium from bauxite ore. Include: (a) Purification of bauxite (b) Electrolytic reduction (c) Why cryolite is added

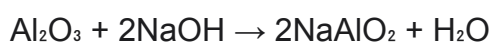
Answer:

Ore: Bauxite ($\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$) – contains impurities Fe_2O_3 , SiO_2

(a) Purification (Bayer's process):

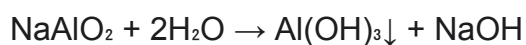
Crushed bauxite digested in hot concentrated NaOH

Al_2O_3 dissolves as sodium aluminate; impurities insoluble:

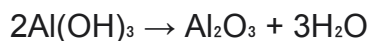


Solution filtered → impurities (red mud) removed

Sodium aluminate hydrolyzed to precipitate pure $\text{Al}(\text{OH})_3$:



$\text{Al}(\text{OH})_3$ heated to get pure alumina:



(b) Electrolytic reduction (Hall-Héroult process):

Pure Al_2O_3 mixed with cryolite (Na_3AlF_6) and fluorspar (CaF_2)

Mixture electrolyzed in steel tank lined with carbon (cathode)

Carbon rods act as anode

Temperature: 950°C

Reactions:

At cathode: $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}(\text{l})$ (Molten aluminium collects at bottom)

At anode: $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^- \rightarrow \text{C} + \text{O}_2 \rightarrow \text{CO}_2$ (Anodes burn away)

(c) Role of cryolite:

(i) Lowers melting point from 2050°C (pure Al_2O_3) to 950°C → saves energy

(ii) Increases conductivity of molten mixture

(iii) Acts as solvent for alumina

Product: 99.5% pure aluminium.

 NCERT Reference: Page 55, Section 3.5.2 "Extracting Metals High up in Reactivity Series" (General electrolytic reduction principle)

****Q8.** (a) Compare physical properties of metals and non-metals in a table (5 points).

(b) Explain why mercury is used in thermometers despite being toxic.

(c) Why is graphite used as electrode while diamond is not? ******

Answer:

(a) Comparison table:

Property

Metals

Non-metals

Lustre

Lustrous (shiny) when freshly cut

Generally dull (except iodine, diamond)

Malleability/Ductility

Malleable & ductile

Brittle (solids); not malleable/ductile

Conductivity

Good conductors of heat & electricity

Poor conductors (except graphite)

State at RT

Solid (except Hg – liquid)

Solids, liquid (Br) or gases

Sonority

Sonorous (ringing sound)

Not sonorous

(b) Mercury in thermometers:

Uniform expansion with temperature → accurate readings

High coefficient of expansion → visible movement in capillary

Does not stick to glass walls

High boiling point (357°C) → wide temperature range measurement

Safety note: Digital thermometers now preferred due to toxicity; mercury thermometers being phased out

(c) Graphite vs Diamond as electrodes:

Graphite: sp^2 hybridized $\rightarrow$ delocalized electrons between layers $\rightarrow$ conducts electricity $\rightarrow$ suitable as electrode

Diamond: sp^3 hybridized $\rightarrow$ all electrons in covalent bonds $\rightarrow$ no free electrons $\rightarrow$ insulator $\rightarrow$ cannot be electrode

 NCERT Reference: Page 40-43, Section 3.1 & 3.2 (Physical properties comparison); Page 42, Table 3.2 footnote (Graphite conductivity)

****Q9.** (a) What is reactivity series? Give its significance.

(b) Arrange: K, Na, Ca, Mg, Al, Zn, Fe, Sn, Pb, H, Cu, Ag, Au in decreasing reactivity.

(c) Explain why: (i) Gold is found native (ii) Aluminium extracted by electrolysis (iii) Iron extracted using coke**

Answer:

(a) Reactivity series: Arrangement of metals in decreasing order of reactivity (ease of losing electrons to form cations).

Significance:

(i) Predicts displacement reactions (more reactive displaces less reactive)

(ii) Determines extraction method (electrolysis for top metals; reduction by C for middle; heating alone for bottom)

(iii) Explains corrosion tendency (more reactive $\rightarrow$ corrodes faster)

(iv) Predicts reaction with water/acids (top metals react with cold water; middle with steam/acids; bottom don't react)

(b) Reactivity series (decreasing):

$K > Na > Ca > Mg > Al > C > Zn > Fe > Sn > Pb > H > Cu > Ag > Au$

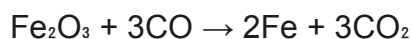
(Note: Carbon and Hydrogen included as reference points)

(c) Explanations:

(i) Gold native: Gold is least reactive metal $\rightarrow$ does not combine with O_2 , H_2O , $CO_2 \rightarrow$ found as free element (native state) in nature

(ii) Aluminium by electrolysis: Aluminium is highly reactive (above carbon in series) → its oxide cannot be reduced by carbon → requires stronger reducing agent (electrons via electrolysis)

(iii) Iron with coke: Iron is moderately reactive (below Al, above H) → its oxide can be reduced by carbon/carbon monoxide (cheaper than electrolysis):



 NCERT Reference: Page 48, Table 3.4 (Reactivity series); Page 54-55, Section 3.5.2 (Extraction methods based on reactivity)

****Q10.** (a) What is ionic bond? Explain formation of MgO.

(b) List four properties of ionic compounds with reasons.

(c) Why do ionic compounds not conduct electricity in solid state?**

Answer:

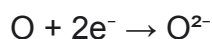
(a) Ionic bond: Chemical bond formed by complete transfer of electrons from metal atom to non-metal atom, resulting in electrostatic attraction between oppositely charged ions.

Formation of MgO:

Magnesium (Mg, 2,8,2): Loses 2 electrons → Mg^{2+}



Oxygen (O, 2,6): Gains 2 electrons → O^{2-}



Mg^{2+} and O^{2-} attract → form MgO crystal lattice

(b) Properties of ionic compounds:

Property

Reason

High melting/boiling points

Strong electrostatic forces require large energy to break

Soluble in water, insoluble in organic solvents

Water (polar) hydrates ions; organic solvents (non-polar) cannot

Conduct electricity in molten/aqueous state

Ions become mobile and carry current

Crystalline solids, brittle

Regular ionic lattice; layers shift under stress causing repulsion

(c) No conduction in solid state:

In solid state, ions are fixed in rigid crystal lattice and cannot move. Electricity conduction requires mobile charge carriers (free electrons or ions). Only when melted/dissolved do ions gain mobility to conduct electricity.

 NCERT Reference: Page 49, Section 3.4 "Properties of Ionic Compounds" (All properties explained)

Q11. Describe the process of concentration of ores. Explain three methods with suitable examples of ores.

Answer:

Concentration (Enrichment): Removal of gangue (earthly impurities) from crushed ore to increase metal percentage.

Three methods:

(i) Hydraulic Washing (Gravity Separation):

Principle: Difference in density between ore and gangue

Process: Ore crushed → washed with high-pressure water stream on inclined table

Result: Lighter gangue washed away; heavier ore particles settle

Ore example: Haematite (Fe_2O_3), Tin stone (SnO_2)

(ii) Froth Flotation:

Principle: Difference in wettability (ore wetted by oil; gangue by water)

Process:

- Crushed ore + water + pine oil (frother) in tank
- Air blown → creates froth
- Ore particles attach to oil froth → float

- Gangue sinks → removed

Ore example: Zinc blende (ZnS), Galena (PbS), Copper pyrites (CuFeS₂)

(iii) Magnetic Separation:

Principle: Difference in magnetic properties

Process: Crushed ore moved on conveyor belt passing over magnetic roller

Result: Magnetic ore particles attracted to roller; non-magnetic gangue falls straight

Ore example: Magnetite (Fe₃O₄ – magnetic iron ore)

Additional method: Leaching (for bauxite using NaOH)

 NCERT Reference: Page 53, Section 3.5.1 "Enrichment of Ores" (All three methods described)

****Q12. (a) What is corrosion? How is it different from rusting?**

(b) Explain rusting of iron with labelled diagram showing electrochemical mechanism.

(c) Why does rusting occur faster in coastal areas?**

Answer:

(a) Corrosion vs Rusting:

Corrosion: General term for deterioration of any metal by environmental reaction (e.g., tarnishing of silver, green coating on copper)

Rusting: Specific term for corrosion of iron and its alloys → formation of hydrated iron(III) oxide

(b) Electrochemical mechanism of rusting:

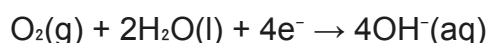
Rusting occurs via electrochemical cells on iron surface:

Anodic areas (oxidation):



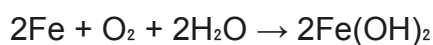
(Iron dissolves at impure spots/scratches)

Cathodic areas (reduction):



(Oxygen reduction at pure iron areas)

Overall reaction:



Ferrous hydroxide oxidizes further:

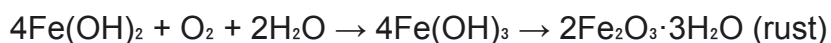


Diagram description:

[Iron surface with water droplet]

Centre of droplet: Anode ($\text{Fe} \rightarrow \text{Fe}^{2+} + 2\text{e}^-$)

Edge of droplet: Cathode ($\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$)

Fe^{2+} and OH^- combine $\rightarrow \text{Fe}(\text{OH})_2 \rightarrow \text{rust}$

(c) Faster rusting in coastal areas:

Sea air contains salt particles (NaCl)

Salts act as electrolytes $\rightarrow$ increase conductivity of water film on iron

Enhanced ion mobility $\rightarrow$ accelerates electrochemical reactions

Chloride ions also form soluble complexes with $\text{Fe}^{2+} \rightarrow$ prevent protective layer formation

 NCERT Reference: Page 56-57, Section 3.7 "Corrosion" (Rusting explanation);
Concept of electrolytes from Chapter 12

****Q13. (a) Why do metals conduct electricity? Explain with metallic bonding.**

(b) Why are metals malleable and ductile?

(c) Why does electrical conductivity of metals decrease with increase in temperature?******

Answer:

(a) Electrical conduction in metals:

Metals have metallic bonding: Positive metal ions in fixed positions surrounded by "sea" of delocalized valence electrons

When potential difference applied, free electrons drift directionally → carry electric current

Example: Copper has one free electron per atom → excellent conductor

(b) Malleability & ductility:

Metal ions arranged in layers held by non-directional metallic bonds

When force applied, layers slide over each other

Delocalized electrons readjust → maintain bonding → no fracture

Contrast: Ionic compounds shatter when layers shift (like charges align → repulsion)

(c) Conductivity decreases with temperature:

As temperature ↑, metal ions vibrate more vigorously about fixed positions

Increased vibration → more collisions between moving electrons and ions

Electrons face greater resistance to flow → conductivity decreases

Note: Opposite behaviour in semiconductors (conductivity increases with temperature)

 NCERT Reference: Page 41, Section 3.1, Para after Activity 3.2 (Metallic bonding explanation); Concepts integrated from Chapter 12 (Electricity)

Q14. Explain the extraction of zinc from zinc blende (ZnS). Include all chemical equations and reasons for each step.

Answer:

Ore: Zinc blende (ZnS) – sulphide ore

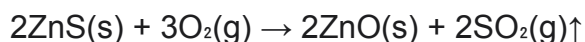
Step 1: Concentration – Froth Flotation

Crushed ore + water + pine oil in tank

Air blown → ZnS particles attach to oil froth → float; gangue sinks

Reason: ZnS is hydrophobic (oil-wetted); gangue hydrophilic (water-wetted)

Step 2: Roasting (Conversion to oxide)

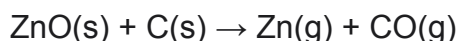


Heated strongly in excess air at ~900°C

Reasons:

- (i) Sulphide ores cannot be reduced directly by carbon
- (ii) Converts to oxide suitable for reduction
- (iii) Removes volatile impurities as gases

Step 3: Reduction



Heated with coke (carbon) at 1673 K in fire clay retorts

Zinc vapor distilled off $\rightarrow$ condensed to liquid zinc

Reason: Zinc is moderately reactive (below Al, above Fe) $\rightarrow$ reducible by carbon

Step 4: Refining – Electrolytic refining

Impure zinc anode; pure zinc cathode; ZnSO_4 electrolyte

At cathode: $\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$ (Pure zinc deposits)

Reason: Removes impurities (Cd, Fe, Cu) for commercial grade zinc

Environmental note: SO_2 from roasting converted to H_2SO_4 to prevent air pollution.

 NCERT Reference: Page 54, Section 3.5.2 "Extracting Metals in the Middle of Reactivity Series" (Zinc extraction flowchart)

****Q15.** (a) What are metalloids? Give three examples with one property each showing intermediate behaviour.

(b) Why is silicon used in computer chips?

(c) How does boron differ from typical metals and non-metals? ******

Answer:

(a) Metalloids: Elements showing properties intermediate between metals and non-metals. Located along zig-zag line in periodic table.

Metalloid

Metallic property

Non-metallic property

Silicon (Si)

Semiconductor (conducts when doped)

Forms acidic oxide (SiO_2)

Germanium (Ge)

Shiny appearance

Brittle solid

Arsenic (As)

Conducts electricity poorly

Forms covalent compounds

(b) Silicon in computer chips:

Silicon is a semiconductor $\rightarrow$ conductivity between conductor and insulator

Conductivity can be precisely controlled by doping (adding impurities like P, B)

Forms stable SiO_2 layer for insulation in integrated circuits

Abundant and economical compared to other semiconductors (Ge)

(c) Boron's intermediate behaviour:

Non-metallic: Forms covalent compounds (BF_3), acidic oxide (B_2O_3), poor conductor

Metallic: High melting point (2076°C), hard solid

Unique: Forms borides with metals showing metallic character

 NCERT Reference: Page 43, Section 3.2, Para 3 (Metalloids mentioned);
Concepts from Chapter 5 (Periodic Classification)

****Q16.** (a) What is anodising? Explain the process with diagram.

(b) Why is anodising done for aluminium articles?

(c) How does anodising differ from galvanization?******

Answer:

(a) Anodising: Electrolytic process to thicken oxide layer on aluminium surface for corrosion resistance and dye absorption.

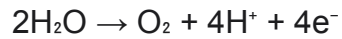
Process:

Aluminium article made anode

Cathode: Lead/Aluminium plate

Electrolyte: Dilute sulphuric acid (15%)

Direct current passed → oxygen liberated at anode:



Oxygen reacts with Al: $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$

Oxide layer grows inward and outward from original surface → thickness increases 2-3x

Diagram description:

[Electrolytic cell]

Anode: Al article | Cathode: Pb plate

Electrolyte: Dil. H_2SO_4

Battery connected → O_2 forms at anode → reacts with Al → thick Al_2O_3 layer

(b) Purpose for aluminium:

(i) Enhanced corrosion resistance – thicker oxide layer better barrier

(ii) Dye absorption – porous oxide layer absorbs dyes → coloured articles (utensils, window frames)

(iii) Increased surface hardness – wear resistance improved

(c) Anodising vs Galvanization:

Parameter

Anodising

Galvanization

Metal treated

Aluminium

Iron/Steel

Coating material

Aluminium oxide (Al_2O_3)

Zinc (Zn)

Process

Electrolytic oxidation

Dipping in molten zinc

Protection type

Barrier protection

Sacrificial + barrier protection

Coating nature

Integral to metal surface

Separate metal layer

 NCERT Reference: Page 57, Section 3.7, Para 5 (Anodising explanation)

****Q17.** (a) Why do non-metals not displace hydrogen from dilute acids?

(b) Explain reaction of non-metals with chlorine with two examples.

(c) Why does hydrogen occupy unique position in periodic table? ******

Answer:

(a) Non-metals and dilute acids:

Non-metals have high electronegativity $\rightarrow$ tendency to gain electrons (form anions)

Displacing hydrogen requires losing electrons to reduce H^+ to H_2 :



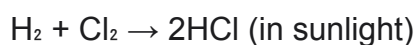
Non-metals cannot supply electrons $\rightarrow$ no reaction with dilute acids

Exception: Some non-metals react with oxidizing acids (HNO_3 , conc. H_2SO_4) but no H_2 evolved (different mechanism)

(b) Non-metals with chlorine:

Non-metals form covalent chlorides by sharing electrons:

Example 1 – Hydrogen:



Hydrogen chloride – colourless gas, acidic in water

Example 2 – Phosphorus:



Phosphorus trichloride/pentachloride – fuming liquids

Note: Covalent chlorides hydrolyze in water $\rightarrow$ acidic solutions (unlike ionic chlorides like NaCl)

(c) Hydrogen's unique position:

Hydrogen shows dual behaviour:

Resembles Alkali Metals (Group 1)

Resembles Halogens (Group 17)

Forms H^+ (like Na^+ , K^+)

Forms H^- hydride ion (like F^- , Cl^-)

Valency = 1

Needs 1 electron for duplet (like halogens need octet)

Combines with non-metals (H_2O , HCl)

Exists as diatomic molecule (H_2 like Cl_2 , O_2)

Thus, hydrogen placed separately in periodic table (top of Group 1 but not alkali metal).

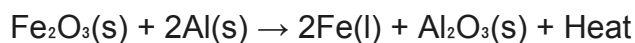
 NCERT Reference: Page 46, Section 3.3.3 "Reaction with Acids" (Non-metals don't react); Page 51, Section 3.4.1 (Covalent chlorides); Concepts from Chapter 5

Q18. Describe the thermite welding process used for joining railway tracks. Include chemical equation, temperature reached, and safety precautions.

Answer:

Thermite welding: Application of highly exothermic thermite reaction to produce molten iron for welding.

Chemical reaction:



($\Delta H = -850 \text{ kJ/mol}$)

Process steps:

Preparation:

Railway track ends aligned with 2-3 cm gap

Refractory mould (sand mould) built around gap

Thermite mixture ($\text{Fe}_2\text{O}_3 + \text{Al}$ powder in 3:1 ratio) placed in crucible above mould

Ignition:

Mixture ignited using Mg ribbon fuse (requires high activation energy $\sim 1200^\circ\text{C}$)

Reaction self-sustaining once started

Welding:

Reaction reaches $\sim 2500^\circ\text{C}$ $\rightarrow$ produces molten iron (melting point 1538°C)

Molten iron flows into mould $\rightarrow$ fills gap between tracks

Molten Al_2O_3 (slag) floats on iron $\rightarrow$ tapped off separately

Metal cools/solidifies $\rightarrow$ strong welded joint

Safety precautions:

- (i) Workers wear heat-resistant suits and face shields
- (ii) Area cleared of flammable materials (intense heat/sparks)
- (iii) Proper ventilation (fumes from reaction)
- (iv) Controlled ignition from safe distance
- (v) Post-weld inspection for cracks/defects

Advantages:

No external power source required

Strong, seamless joint

Quick process (5-10 minutes per weld)

 NCERT Reference: Page 48, Section 3.3.4, Box item after Activity 3.17 (Thermite reaction application)

****Q19.** (a) What is the role of flux in metallurgy? Differentiate between acidic and basic flux.

(b) Explain extraction of copper from copper glance (Cu_2S).

(c) Why is blister copper called so?******

Answer:

(a) Flux role: Substance added during smelting to remove gangue by forming fusible slag.

Flux Type

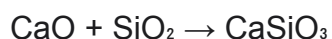
Used When Gangue Is

Reaction Example

Slag Formed

Acidic flux (SiO_2)

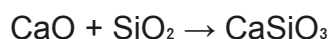
Basic (CaO , FeO)



Calcium silicate

Basic flux (CaO , CaCO_3)

Acidic (SiO_2 , P_4O_{10})



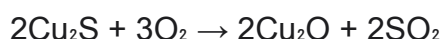
Calcium silicate

Principle: Acidic flux removes basic impurities; basic flux removes acidic impurities.

(b) Extraction of copper from copper glance (Cu_2S):

Step 1: Concentration – Froth flotation (Cu_2S hydrophobic)

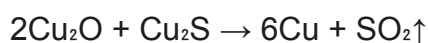
Step 2: Roasting (Partial):



(Not complete roasting – mixture of Cu_2S + Cu_2O obtained)

Step 3: Smelting in Bessemer converter:

Self-reduction occurs without external reducing agent:



(Molten copper settles at bottom)

Step 4: Refining – Electrolytic refining to 99.95% pure copper

(c) Blister copper:

~98% pure copper obtained after smelting

Called "blister" because SO_2 gas bubbles trapped during solidification create blistered surface

Contains impurities (Fe, Zn, Ag, Au, Pt) → requires electrolytic refining

 NCERT Reference: Page 55, Section 3.5.2 (Flux concept implied in iron extraction); Page 56, Section 3.5.3 (Refining of copper)

****Q20.** (a) Explain why: (i) Sodium chloride conducts electricity in aqueous solution but not in solid state (ii) Graphite conducts electricity but diamond does not

(b) Why are ionic compounds hard but brittle?

(c) How does alloying change properties of metals? Give three examples. ******

Answer:

(a) Conductivity explanations:

(i) NaCl conductivity:

Solid state: Ions fixed in lattice → no mobility → no conduction

Aqueous solution: Water molecules hydrate ions → $\text{Na}^+(\text{aq})$ and $\text{Cl}^-(\text{aq})$ become mobile → carry current when potential applied

(ii) Graphite vs Diamond:

Graphite: sp^2 hybridized $\rightarrow$ layered structure with delocalized π -electrons between layers $\rightarrow$ electrons move freely $\rightarrow$ conducts electricity

Diamond: sp^3 hybridized $\rightarrow$ tetrahedral network with all valence electrons in strong covalent bonds $\rightarrow$ no free electrons $\rightarrow$ insulator

(b) Hard but brittle nature of ionic compounds:

Hardness: Strong electrostatic forces hold ions firmly in lattice $\rightarrow$ resists deformation

Brittleness: When force applied, layers shift $\rightarrow$ ions of same charge align $\rightarrow$ strong repulsion $\rightarrow$ crystal shatters along planes

(Contrast with metals: layers slide without repulsion due to delocalized electrons)

(c) Alloying effects on properties (three examples):

Pure Metal

Alloy

Property Change

Application

Gold (soft)

22 carat gold (Au + Cu/Ag)

Increased hardness & strength

Jewellery that retains shape

Iron (rusts easily)

Stainless steel (Fe + Cr + Ni)

Corrosion resistance

Surgical instruments, cutlery

Tin + Lead (high mp)

Solder (Sn + Pb)

Lower melting point (180°C)

Joining electrical components

Additional: Brass (Cu+Zn) – more malleable than pure copper; Duralumin (Al+Cu+Mg) – stronger than pure aluminium for aircraft

 NCERT Reference: Page 49, Section 3.4 (Ionic compound properties); Page 42, Table 3.2 footnote (Graphite conductivity); Page 56, Section 3.6 (Alloys)

 HOW TO USE THESE QUESTIONS EFFECTIVELY:

Question Type

Recommended Practice Strategy

Short Answer (2-3 marks)

- Write answers in 30-50 words
- Include 1 diagram/equation where relevant
- Practice time: 2-3 minutes per question

Long Answer (5 marks)

- Structure: Introduction → Explanation → Diagram → Conclusion
- Word limit: 80-120 words
- Practice time: 5-7 minutes per question

Revision

- Create flashcards for each question
- Self-test weekly using these questions
- Compare answers with NCERT textbook language

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