🔩 METALS

Physical Properties

✔ Lustrous (shiny)
✔ Malleable (sheets)
✔ Ductile (wires)
✔ Good conductors of heat & electricity
✔ Sonorous
✔ Mostly solids (exception: **Hg – liquid**)

Exceptions:
- Na, K – soft, low melting point
- Iodine – lustrous non-metal
- Graphite – non-metal but conducts electricity

Chemical Properties

(A) With Oxygen
Metal + O_2 → Metal oxide (mostly **basic**)
- **Amphoteric oxides**: Al_2O_3, ZnO

(B) With Water (Reactivity order)
K, Na (violent) > Ca > Mg (hot water) >

Al, Fe, Zn (steam) > Cu, Ag, Au (no reaction)

(C) With Acids
Metal + Acid → Salt + H_2
- Cu does **not** react with dilute HCl
- HNO_3 usually does not give H_2

(D) Displacement Reaction
More reactive metal displaces less reactive one:
Fe + $CuSO_4$ → $FeSO_4$ + Cu

🧲 CORROSION

Examples:

- Rusting of Iron (requires: Air + Water) $Fe_2O_3 \cdot xH_2O$
- Silver → black (Ag_2S)
- Copper → green (basic copper carbonate)

Prevention

✔Painting, oiling, greasing
✔ **Galvanization (Zn coating)**
✔ **Alloying** (e.g., stainless steel)

Why galvanised iron does not rust easily?
→ Zinc is **more reactive**, so it corrodes first (sacrificial protection).

📊 REACTIVITY SERIES

K > Na > Ca > Mg > Al > Zn > Fe > Pb > H > Cu > Hg > Ag > Au

Uses:
✔ Predict displacement reactions
✔ Decide extraction method
✔ Metals above H displace H_2 from acids

Example: ✔ Zn + $FeSO_4$ → **No reaction**
✔Fe + $CuSO_4$ → **Displacement occurs**

⚡ IONIC COMPOUNDS

- Formed by **transfer of electrons**
- Metals → cations (+) | Non-metals → anions (–)

Properties:
✔ Hard, brittle solids
✔ High melting & boiling points
✔ Soluble in water
✔ Conduct electricity in **molten/aqueous state**, not solid

Example: $Na^+ + Cl^- \rightarrow NaCl$

🌍 OCCURRENCE OF METALS

- **Mineral:** Naturally occurring compound
- **Ore:** Mineral from which metal can be extracted profitably
- Found as **free elements** (Au, Ag, Cu) or **compounds**

🧩 ALLOYS

Homogeneous mixtures of metals (or metal + non-metal)
Improve strength, hardness, corrosion resistance.
Examples:
- **Brass:** Cu + Zn
- **Bronze:** Cu + Sn
- **Solder:** Pb + Sn
- **Stainless steel:** Fe + Cr + Ni

🧠 NON-METALS (KEY POINTS)

- Gain electrons → negative ions
- Form **acidic/neutral oxides**
- Do **not** displace hydrogen from acids
- Form **hydrides** with hydrogen

⚙️ EXTRACTION OF METALS (METALLURGY)

(A) Low Reactivity (Cu, Hg)

✔ By **heating alone**
$2HgO \rightarrow 2Hg + O_2$

(B) Medium Reactivity (Fe, Zn, Pb)

Step 1: Concentration of ore
Step 2: Convert to oxide
- **Roasting**: Sulphide → Oxide
- **Calcination**: Carbonate → Oxide

Step 3: Reduction with Carbon
$ZnO + C \rightarrow Zn + CO$

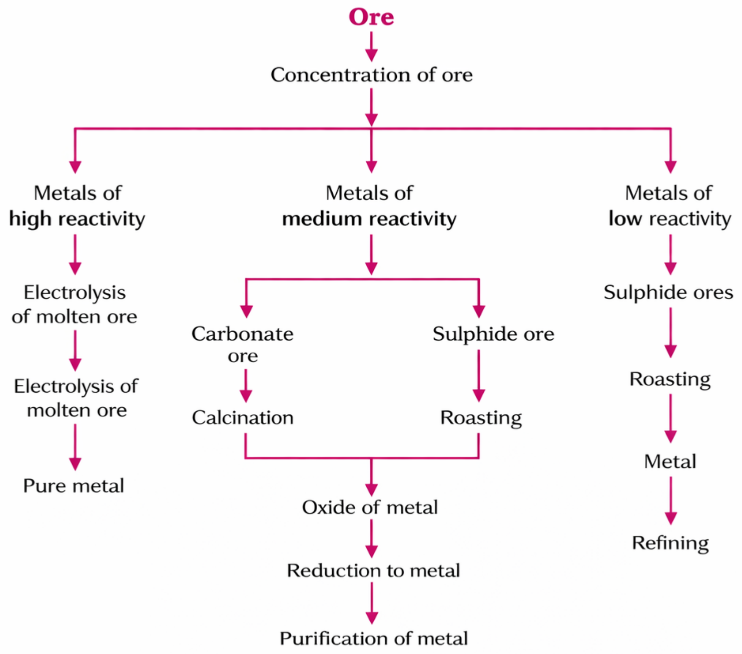
Thermite Reaction (welding):
$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3 + \text{Heat}$

(C) High Reactivity (Na, K, Ca, Al)

✔ By **electrolysis of molten compounds**
$Na^+ + e^- \rightarrow Na$ (cathode)
$2Cl^- \rightarrow Cl_2 + 2e^-$ (anode)

(D) Refining of Metals

Electrolytic Refining:
- Impure metal → anode
- Pure metal → cathode
- Impurities → **anode mud**



Steps involved in the extraction of metals from ores

⭐ EXAM MEMORY TRIGGERS

✔ Liquid metal → **Mercury (Hg)**
✔ Conducting non-metal → **Graphite**
✔ Amphoteric oxides → **Al_2O_3, ZnO**
✔ Thermite reaction → **Al + Fe_2O_3**
✔ Rusting needs → **Air + Water**
✔ Most reactive metal → **Potassium**
✔ Ionic compounds conduct → **Molten/Aqueous, not solid**

Extraction: "Which Method & Why?"

Reactivity Level	Method	Why
Low (Cu, Hg)	Heating alone	Weak metal-oxygen bond
Medium (Fe, Zn, Pb)	Roasting/Calcination → Reduction with carbon	Carbon can reduce oxides
High (Na, K, Ca, Al)	Electrolysis	Carbon cannot reduce their oxides

✔ Why is **copper used for electric wires?**
→ Good conductor, ductile

✔ Why is **aluminium used for cooking utensils?**
→ Forms protective oxide layer, good conductor

✔ Why are **Na, K stored in kerosene?**
→ React violently with air and moisture

✔ Why are **carbonate & sulphide ores converted to oxides before reduction?**
→ Oxides are easier to reduce than sulphides/ carbonates

✔ Why is **tin used for coating food cans and not zinc?**
→ Zinc is more reactive → may react with food

Reactions of Metals

(A) With Oxygen

- $2Cu + O_2 \rightarrow 2CuO$
- $4Al + 3O_2 \rightarrow 2Al_2O_3$

(B) With Water

- $2Na + 2H_2O \rightarrow 2NaOH + H_2$ + heat
- $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$
- $3Fe + 4H_2O$ (steam) $\rightarrow Fe_3O_4 + 4H_2$

(C) With Acids

- $Zn + 2HCl \rightarrow ZnCl_2 + H_2$
- $Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$

⚠ Trick question:

→ Copper does NOT react with dilute acids
→ Nitric acid usually does not give H_2 gas

Ionic compounds Property	Reason
High melting point	Strong electrostatic forces
Conduct in molten/ aqueous state	Free moving ions
Do not conduct in solid state	Ions fixed in lattice
Soluble in water	Polar nature

✔ **Mineral:** Naturally occurring compound containing a metal
✔ **Ore:** Mineral from which metal can be **profitably extracted**
✔ **Gangue:** Unwanted impurities in ore (sand, soil, rock)
✔ **Roasting:** Heating **sulphide ores in excess air**
✔ **Calcination:** Heating **carbonate ores in limited or no air**
✔ **Alloy:** Homogeneous mixture of two or more metals or a metal + non-metal
✔ **Corrosion:** Slow destruction of metal by air, moisture, or chemicals

Amphoteric Oxides

Definition: Oxides that react with both acids and bases.

✔ **Al_2O_3** and **ZnO**

Examples:

- $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$
- $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

Typical CBSE “Reason” Questions

✔ Why is **copper used for electric wires?**
→ Good conductor, ductile

✔ Why is **aluminium used for cooking utensils?**
→ Forms protective oxide layer, good conductor

✔ Why are **Na, K stored in kerosene?**
→ React violently with air and moisture

✔ Why are **carbonate & sulphide ores converted to oxides before reduction?**
→ Oxides are easier to reduce than sulphides/ carbonates

✔ Why is **tin used for coating food cans and not zinc?**
→ Zinc is more reactive → may react with food

Case Study 1: Extraction of Metals

A student studies the extraction of different metals from their ores. She observes that highly reactive metals are extracted by electrolysis, moderately reactive metals by reduction with carbon, and less reactive metals by heating alone. She also notes that sulphide ores are first roasted before reduction.

Questions:

(a) Why are highly reactive metals extracted by electrolysis?
(b) Why are sulphide ores converted into oxides before reduction?
(c) Name the process used to convert carbonate ores into oxides.
(d) Write one chemical equation for reduction of a metal oxide using carbon.

Answers:

(a) Highly reactive metals cannot be reduced by carbon because they have a strong affinity for oxygen. Hence, they are extracted by electrolysis.
(b) Sulphide ores are difficult to reduce directly. Oxides are easier to reduce, so sulphide ores are first converted into oxides.
(c) The process is called **calcination**.
(d)
$ZnO + C \rightarrow Zn + CO$

Case Study 2: Reactivity Series and Displacement

Four metals A, B, C and D were tested for displacement reactions. The following observations were made:

Metal	$CuSO_4$ solution	$FeSO_4$ solution
A	Displacement	Displacement
B	Displacement	No reaction
C	No reaction	No reaction
D	No reaction	No reaction

Questions:

(a) Which metal is the most reactive?
(b) Which metal is the least reactive?
(c) Which metal is more reactive: iron or copper?
(d) Arrange the metals A, B, C and D in decreasing order of reactivity.

Answers:

(a) Metal **A** is the most reactive.
(b) Metals **C or D** are the least reactive.
(c) Iron is more reactive than copper.
(d) A > B > C = D (no sufficient data to say which of C and D is more reactive

Case Study 3: Ionic Compounds

Sodium chloride is a solid ionic compound. It does not conduct electricity in solid form but conducts when molten or dissolved in water.

Questions:

(a) Why does sodium chloride not conduct electricity in solid state?
(b) Why does it conduct electricity in molten state?
(c) Name the type of bond present in sodium chloride.
(d) State one physical property of ionic compounds.

Answers:

(a) In solid state, ions are fixed and cannot move.

(b) In molten state, ions are free to move and carry electric current.

(c) Ionic (electrovalent) bond

(d) High melting point / Hard and brittle / Soluble in water (any one).