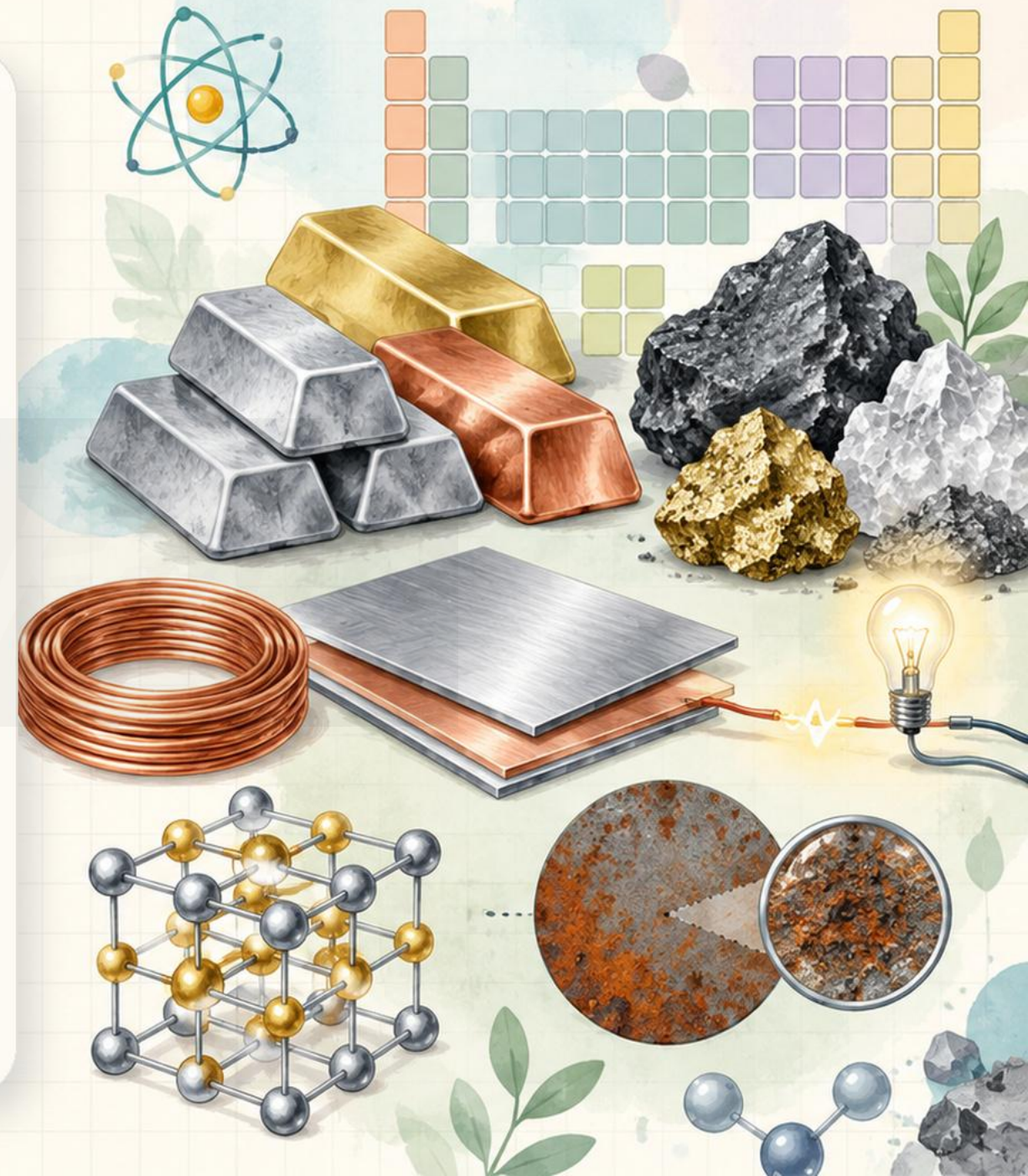


SCIENCE • CLASS 10

CHAPTER 3

# Metals and Non-metals

CHAPTER NOTES



# METALS AND NON-METALS: PHYSICAL PROPERTIES

## METALS — GENERAL PROPERTIES

- Lustrous: clean surface shines (metallic lustre)
- Generally hard; mostly solids at room temperature
- Malleable: beaten into thin sheets
- Ductile: drawn into thin wires
- Good conductors of heat and electricity
- Sonorous: ring when struck



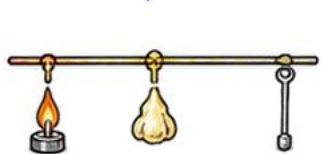
Shiny metal (sample)



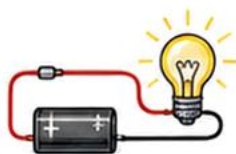
Beaten into thin sheet



Drawn into thin wire



Heat conducts along wire; wax melts; pin falls



Good conductor (electricity)



Rings when struck (sonorous)

## NON-METALS — GENERAL PROPERTIES

- Usually dull; solids are often brittle
- Not malleable or ductile
- Generally poor conductors of heat and electricity
- Not sonorous
- May be solid, liquid or gas



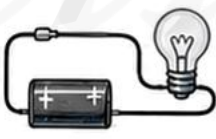
Brittle (e.g., coal or sulphur breaks)



Not malleable (cannot make sheets)



Not ductile (cannot make wires)



Poor conductor (electricity)



Solid (e.g., coal)



Liquid (e.g., bromine)



Gas (e.g., oxygen)

## KEY DEFINITIONS & FACTS

- Metallic lustre = shining surface of a clean metal
- Malleability = ability to be beaten into thin sheets
- Ductility = ability to be drawn into thin wires
- Allotrope = a different structural form of the same element
- Gold and silver: most malleable
- Gold: most ductile — about 2 km wire from 1 g
- Silver and copper: best heat conductors
- Lead and mercury: comparatively poor heat conductors
- PVC/rubber coating insulates electric wires.

## IMPORTANT EXCEPTIONS

Mercury:  
liquid metal



Bromine:  
liquid non-metal



Gallium and caesium:  
metals with very low  
melting points



Iodine:  
lustrous non-metal



Graphite: non-metal  
that conducts electricity



Diamond: hardest  
natural substance; very high  
melting and boiling points



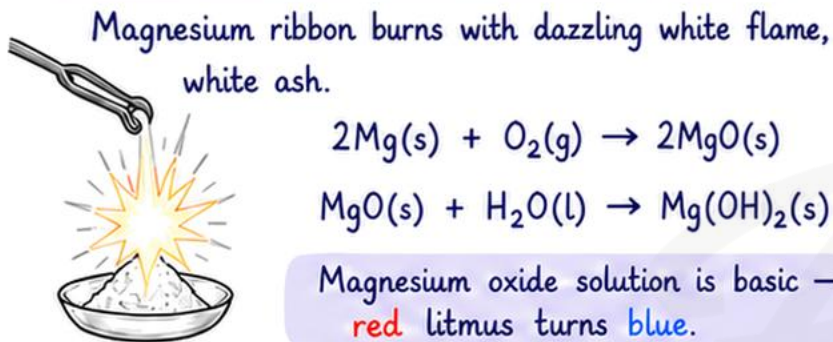
Lithium, sodium and potassium are **soft metals** with low density and low melting point.

# METALS AND NON-METALS: REACTIONS WITH OXYGEN

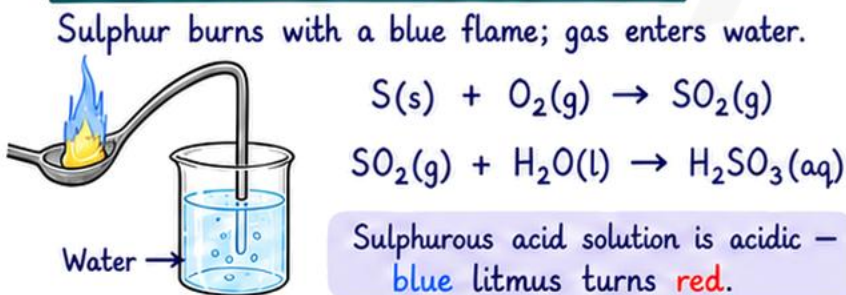
Almost all metals combine with oxygen to form metal oxides.



## MAGNESIUM OXIDE (BASIC)

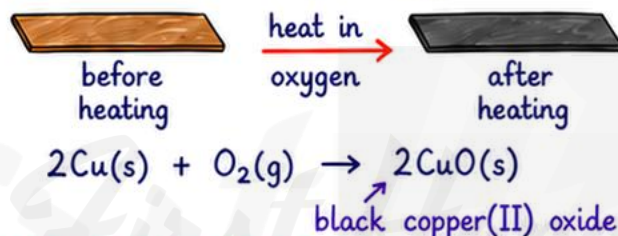


## SULPHUR DIOXIDE (ACIDIC)

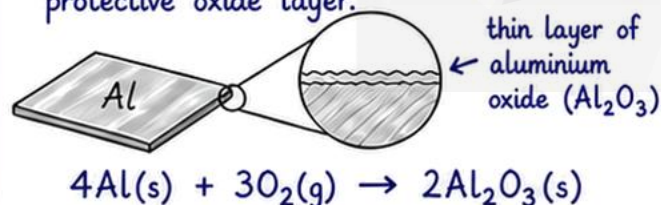


## OTHER METAL OXIDES

Copper strip: brown before heating, black after heating in oxygen.



Aluminium is coated with a thin, protective oxide layer.



Most metal oxides are basic. Many non-metal oxides are acidic; some are neutral.

## AMPHOTERIC OXIDES

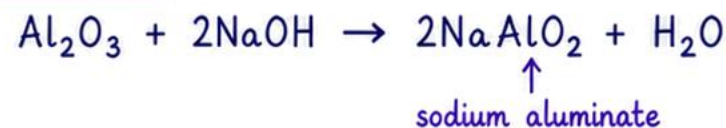
Amphoteric oxides react with both acids and bases to form salt and water.

Examples:  $\text{Al}_2\text{O}_3$  and  $\text{ZnO}$

With acids

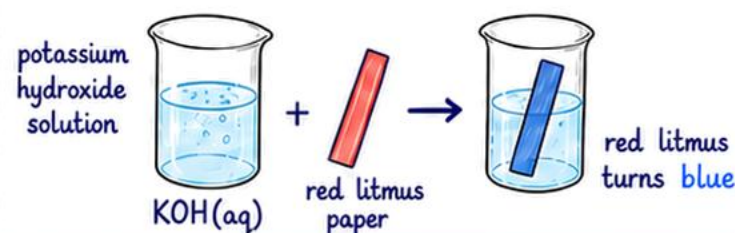
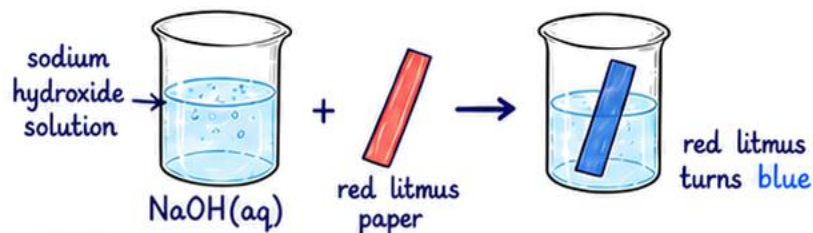
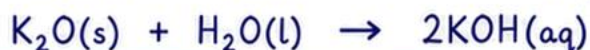


With bases



## OXIDES THAT FORM ALKALIS IN WATER

Some metal oxides dissolve in water to form alkalis.



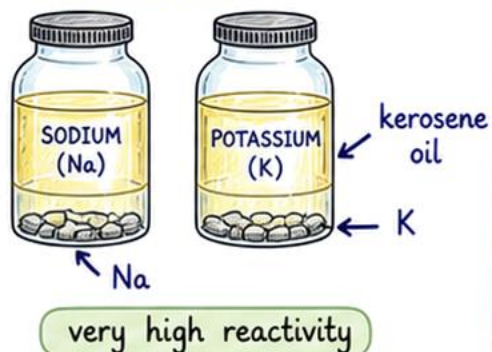
# METALS: REACTIVITY WITH OXYGEN

Metals react with oxygen at different rates.  
Greater reactivity → faster and more vigorous oxidation

## BEHAVIOUR IN AIR / OXYGEN

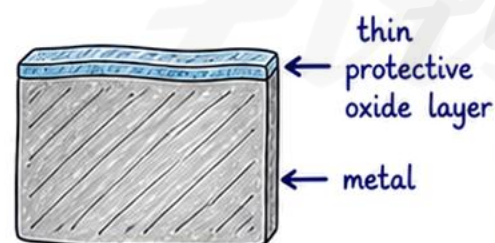
### POTASSIUM & SODIUM

React so vigorously that they may catch fire in open air.  
Stored immersed in kerosene oil.



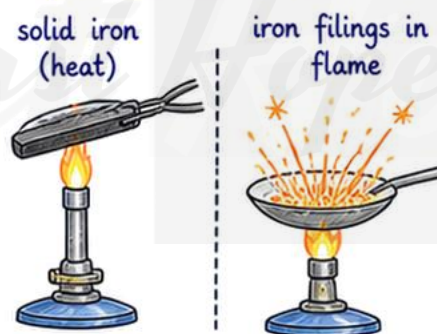
### MAGNESIUM, ALUMINIUM, ZINC & LEAD

At room temperature, a thin oxide layer forms.  
This protective layer prevents further oxidation.



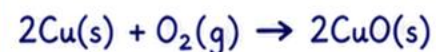
### IRON

Iron does not burn on ordinary heating.  
Iron filings burn vigorously when sprinkled into a flame.



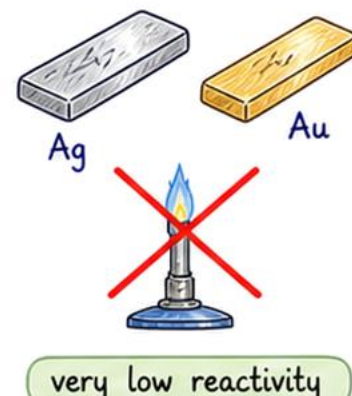
### COPPER

Copper does not burn.  
Hot copper gets a black coating of copper(II) oxide.



### SILVER & GOLD

Do not react with oxygen even at high temperatures.



REACTIVITY TOWARDS OXYGEN GENERALLY DECREASES →

K, Na — very high

Mg, Al, Zn, Pb — protective films

Fe — filings burn

Cu — black oxide on heating

Ag, Au — very low



### WHY KEROSENE?

Kerosene keeps highly reactive potassium and sodium away from air and moisture, preventing accidental fire.



### PASSIVATION:

A thin, tightly attached oxide film protects the metal beneath from further oxidation.



### KEY IDEA:

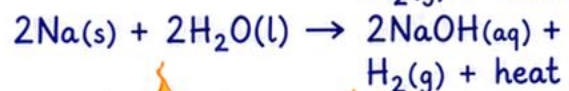
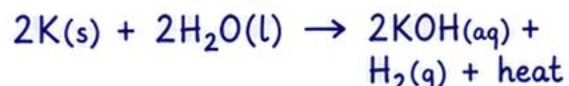
Surface condition matters: iron filings burn because their large surface area contacts more oxygen.

# REACTIONS OF METALS WITH WATER

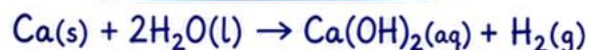


## COLD WATER

**K** and **Na**: very violent and exothermic;  $\text{H}_2$  catches fire.

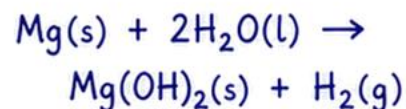
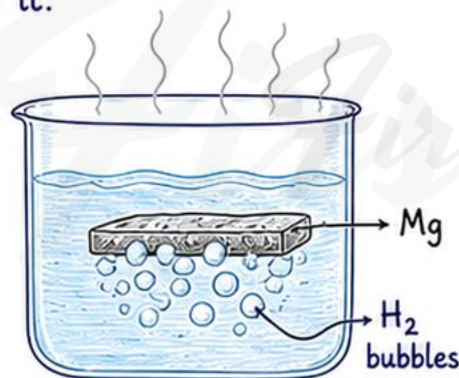


**Ca**: less violent;  $\text{H}_2$  does not catch fire. Calcium floats because  $\text{H}_2$  bubbles stick to it.



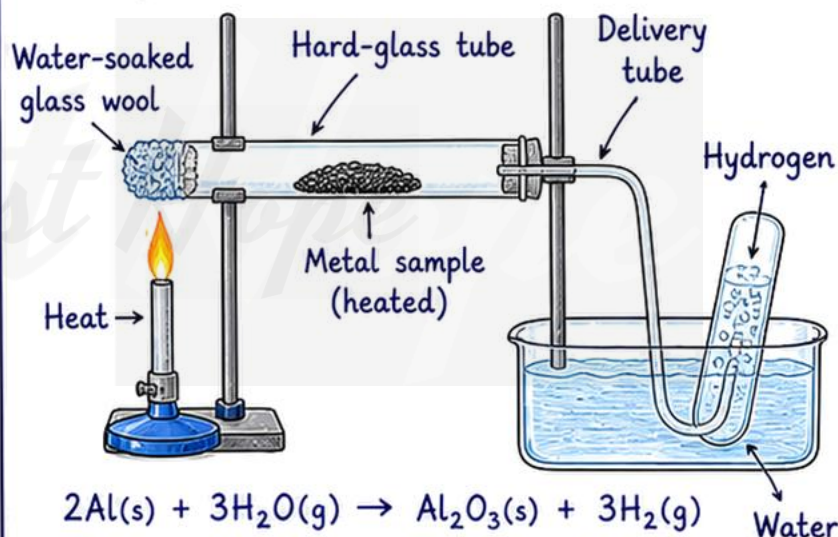
## HOT WATER

Magnesium does not react with cold water. In hot water it floats as  $\text{H}_2$  bubbles stick to it.



## STEAM

Aluminium, zinc and iron react with steam, not cold or hot water.



## NO REACTION

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



## DECREASING REACTIVITY WITH WATER:



## KEY IDEA:

Different metals need different conditions; not every metal forms a hydroxide directly.

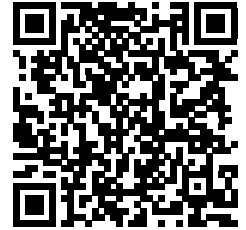


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