

# Chapter 15 : Reactivity Series

## The Reactivity Series

★ Metals in the reactivity series are arranged from **most reactive to least reactive**

★ The reactivity of these metals are based on :

- ↳ Reactivity with **cold water**
- ↳ Reactivity with **steam**
- ↳ Reactivity with **dilute hydrochloric acid**

★ The reactivity series can be used to explain :

- ↳ **Displacement** reactions of metals
- ↳ Reaction of **metal and metal oxides**
- ↳ **Reduction** of metal oxides with **carbon and hydrogen**
- ↳ **Action of heat** on metal carbonates

|             |  |           |
|-------------|--|-----------|
| ★ Potassium |  | Please    |
| Sodium      |  | Send      |
| Calcium     |  | Cats      |
| Magnesium   |  | Monkeys   |
| Aluminium   |  | And       |
| Carbon      |  | Cartoon   |
| Zinc        |  | Zebra     |
| Iron        |  | In        |
| Lead        |  | Large     |
| Hydrogen    |  | Heavy     |
| Copper      |  | Crates    |
| Silver      |  | Soon      |
| (Gold)      |  | (Goodbye) |

Can react with hydrochloric acid

Can be reduced by carbon to their metals

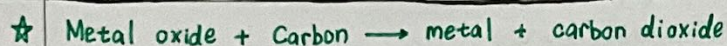
| Metal     | *Reaction with water | *Reaction with HCl | *Reaction with steam |
|-----------|----------------------|--------------------|----------------------|
| Potassium | very violently       | explosively        |                      |
| Sodium    | violently            |                    | explosively          |
| Calcium   | readily              | violently          |                      |
| Magnesium | slowly               | readily            | violently            |
| Zinc      |                      |                    | readily              |
| Iron      | no reaction          | slowly             | slowly               |
| Lead      |                      | no reaction        | no reaction          |

★ :  $\text{metal} + \text{H}_2\text{O} (l) \rightarrow \text{metal hydroxide} + \text{H}_2$





### Reaction of metal oxides and carbon



★ Only metals **BELOW CARBON** can be reduced by carbon

↳ Zinc (Zn)

↳ Iron (Fe)

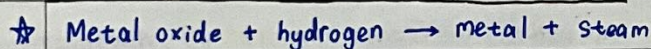
↳ Lead (Pb)

↳ Copper (Cu)

↳ Silver (Ag)

↳ Gold (Au)

### Reaction of metal oxides and hydrogen



★ Only metal oxides **BELOW ZINC** can be reduced by hydrogen

↳ Iron (Fe)

↳ Lead (Pb)

↳ Copper (Cu)

↳ Silver (Ag)

↳ Gold (Au)

### Displacement of metals

★ A more reactive metal has a **higher tendency** to form positive ions than a less reactive metal.

★ A **more reactive metal** can **displace a less reactive metal** from its salt solution.

### Example of displacement + Conclusion:

**Scenario:** Iron fillings are poured into a beaker of blue copper (II) sulfate solution.

#### **Observations:**

↳ Blue copper (II) sulfate turns pale green

↳ Pink deposit of copper forms

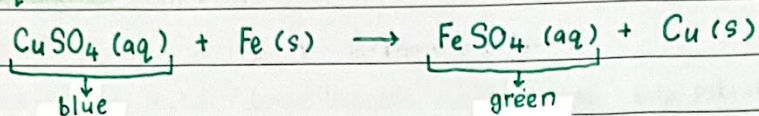
#### **Reasons:**

↳ Iron is more reactive than copper.

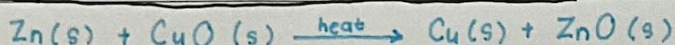


↳ Hence, iron will displace copper from copper (II) sulfate solution.

Equations:



Displacement of metals (metal oxides)



★ As zinc is more reactive than copper, when zinc is heated with copper oxide, zinc oxide and reddish-brown copper metal is formed.

★ Like displacement of metal ions, more reactive metals displace the oxides of less reactive metals.

Thermal decomposition of metal carbonates

★ The more reactive a metal is, the more difficult it is to decompose its carbonate by heat.

★ The more reactive the metal is, the more stable the carbonate.

| Metal carbonate       | Observation                                                                  |
|-----------------------|------------------------------------------------------------------------------|
| Potassium carbonate   | Unaffected by heat as they are very stable.                                  |
| Sodium carbonate      |                                                                              |
| Calcium carbonate     | Decomposes into its metal oxide and carbon dioxide on heating.               |
| Magnesium carbonate   |                                                                              |
| zinc carbonate        |                                                                              |
| Iron (II) carbonate   |                                                                              |
| Lead (II) carbonate   |                                                                              |
| Copper (II) carbonate |                                                                              |
| Silver carbonate      | Decomposes into silver and $\text{CO}_2$ as silver oxide is not heat stable. |

Extraction of metals from their ores

★ Metals above carbon are broken down to its elements by electrolysis.

★ Metals below carbon are broken down to its elements using carbon.

★ Metals like iron, lead and copper are broken down to its elements using hydrogen.

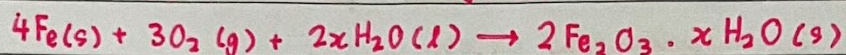


### Conditions for rusting

★ Rusting of iron requires the presence of water and oxygen to occur.

★ Acidic and salty conditions speed up the process of rusting.

★ Iron + oxygen + water  $\rightarrow$  hydrated iron (III) oxide



### Prevention of rusting

★ Barrier methods that prevent contact of iron with oxygen and water:

↳ Painting

↳ Oiling / Greasing

↳ Coating with plastic

★ Sacrificial protection:

↳ Galvanising or coating w zinc

↳ Attaching a more reactive metal like zinc / magnesium