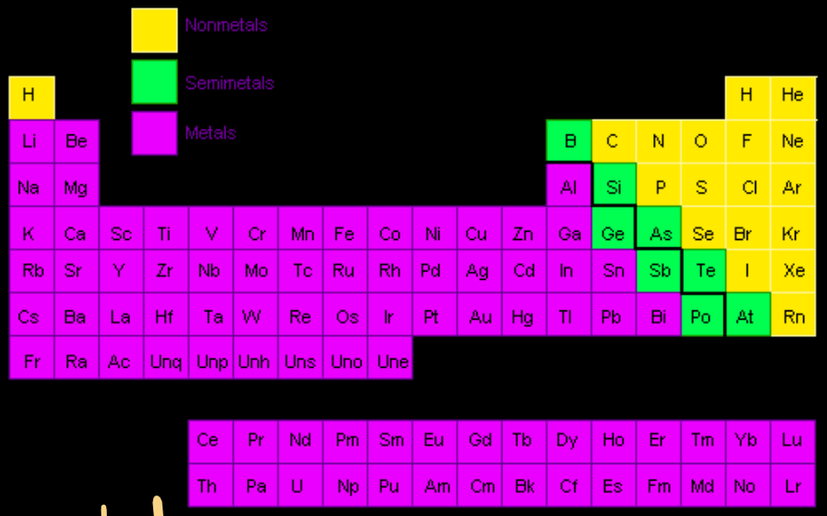
METALS

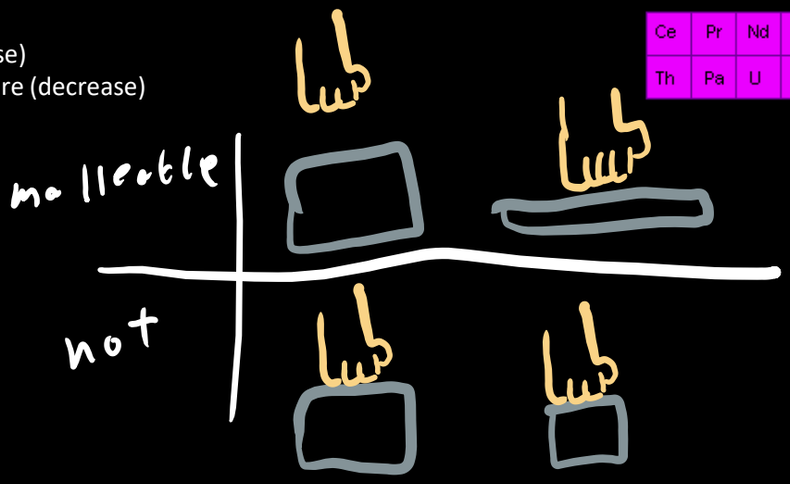
They are substances which can be elements, compounds or alloys that are typically hard, opaque, shiny, and have good electrical and thermal conductivity



PROPERTIES OF METALS

PHYSICAL

- **Malleability**
  - Is the degree to which a metal can be **flattened out** in all directions by rolling or hammering, it depends on factors like
    - Toughness
    - Tensile strength
    - Temperature (increase)
    - Coarseness of grains (decrease)
    - Changes in crystalline structure (decrease)
  - The most malleable materials ranked
    1. Gold
    2. Silver
    3. Copper
    4. Tin
    5. Platinum
    6. Lead
    7. Zinc
    8. Iron
    9. Nickel



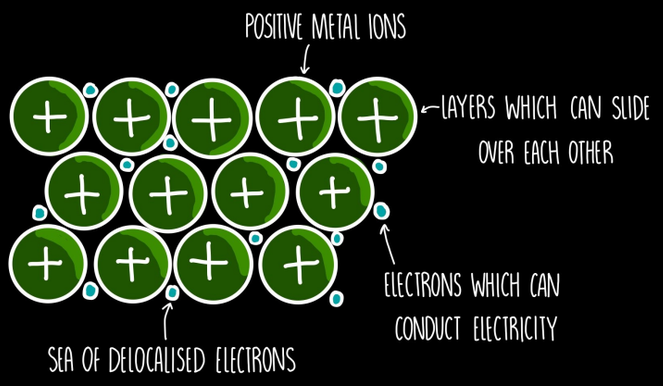
- **Ductility**
  - Is the degree to which a metal is capable of being lengthened by applying tensile strength to it
  - The most ductile metals are
    - Gold
    - Silver
    - Platinum
    - Iron
    - Nickel
    - Copper
    - Zinc
    - Tin
    - Lead

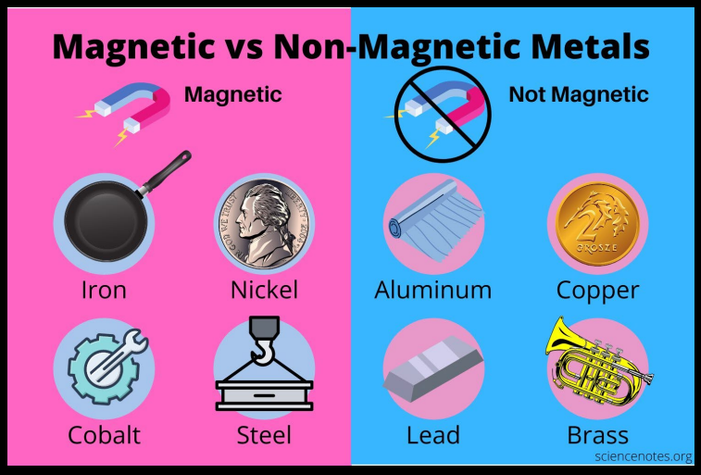
- **Electrical and Thermal Conductivity**
  - The property responsible for transmitting heat & electricity
  - Conducting electricity works by
    - Magnetic field affecting the delocalized electrons making them move in the metal generating an electric current

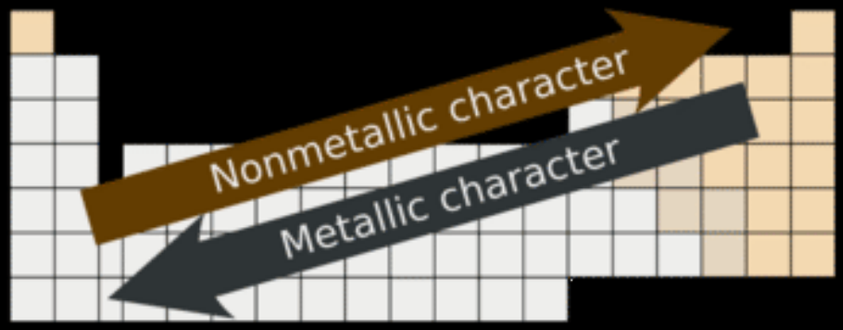
  - Conducting electricity works by
    - Electrons picking up heat energy making them gain additional kinetic energy and move faster throughout the metal, thus, conducting the heat

  - Electric conductivity is reduced when temperature increases, why?
    - When temperature increases, the vibration of metal ions increases. This results in increase in resistance of metal and hence, decrease in conductivity

- **Metallic bonding**
  - Metals bond with each other, it works when the positive metal ions attract the valence electrons from all side generating a sea of delocalized electrons
- **State of matter**
  - Most metals are solid at room temperature beside mercury
- **Magnetism**
  - magnets attract materials that have unpaired electrons that spin in the same direction. In other words, the quality that turns a metal into a magnet also attracts the metal to magnets.
  - Many other elements are diamagnetic, their unpaired atoms create a field that weakly repels a magnet







According to the periodic table, **metals get more reactive they get**

Chemical activity series

it is the arrangement of metals according to their reactivity
it tells us that
- Higher metals can replace lower metals in compounds and not the opposite
- What metals to use for wiring, jewelry, building structures, etc (unreactive)

Activity Series of Metals	
Name	**Symbol**
lithium	Li
potassium	K
calcium	Ca
sodium	Na
magnesium	Mg
aluminum	Al
zinc	Zn
iron	Fe
tin	Sn
lead	Pb
hydrogen*	H
copper	Cu
mercury	Hg
silver	Ag
platinum	Pt
gold	Au

* Hydrogen is not a metal but it behaves like a metal in some chemical reactions so it is included in the activity series.

Metals exist in two forms
- Neutral metal atoms in a piece of shiny metal
- Positively charged metal ions in slats that can be dissolved in water to form solutions, no metal can exist in **NEGATIVE ION FORM**

OXIDATION REACTION
It is the loss of one or more electrons

$$Cu \rightarrow Cu^{2+} + 2e^-$$

REDUCTION REACTION
It is the gaining of one or more electrons

$$Cu^{2+} + 2e^- \rightarrow Cu$$

An oxidation equation turned backwards represents a reduction

OXIDATION-REDUCTION (Redox) REACTION:
It's a chemical reactions where electrons are transferred from one substance to another, and it happens between **neutral metal atoms** like **zinc** and **metal ions** like Cu^{+2}

It goes something like this

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$$

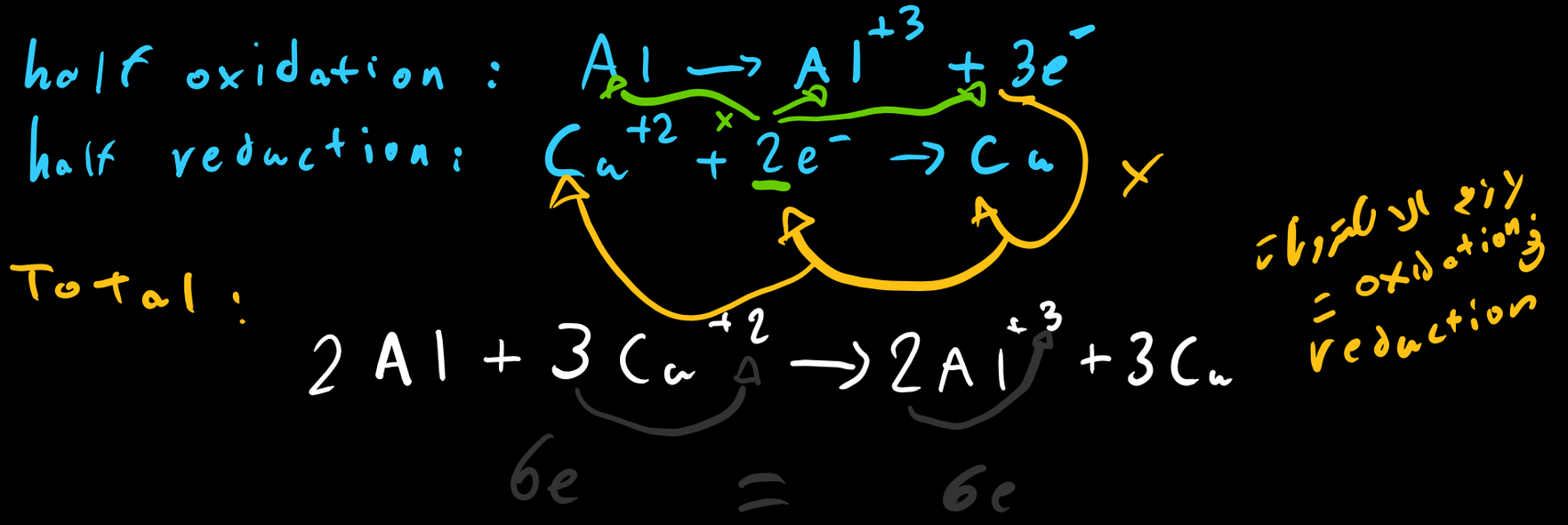
Here you can slice this total reaction into two half-reactions
Where

- Zinc metal oxidizes : **$Zn \rightarrow Zn^{2+} + 2e^-$**
- copper metal reduces : **$Cu^{2+} + 2e^- \rightarrow Cu$**

Here is the main rules of redox reactions

- You can use half-reactions to balance redox equations by making sure the number of electrons lost is equal to the number of electrons gained. For example, when zinc metal oxidizes, copper ions reduce
- The ion that gets reduced is called **oxidizing agent**
- The atom that gets oxidized is called **reducing agent**
- the reactions starts with the reducing agent then oxidizing agent "it makes it easier to understand the next point"
- Redox reactions will occur naturally in one direction "in the reactivity series", from the most reactive to the least reactive, **which means that the reducing agent must be more reactive than the oxidizing agent**
- When a redox reaction is **spontaneous**, it means that all previous rules have been followed and the reaction can happen naturally
- When a redox reaction is non-**spontaneous**, it means that one of the rules was broken and the reaction can't happen naturally

Here is an example of half-reactions and total reactions



Here the

- Oxidizing agent : Cu^{2+}
- Reducing agent : Al
- Oxidized form : Al^{+3}
- Reduced form : Cu
- Transferred electrons : 6

When Is a Metal Not a Metal?

You may wonder why hydrogen is included in the Metal Activity Series when it is clearly not a metal. Metals, in general, are solid, shiny, ductile, malleable, and conductive of heat and electricity. Hydrogen is none of these since it is a gas. However, hydrogen takes on the positive nature of a metal in its role in strong acids, such as hydrochloric (HCl vs. NaCl), sulfuric (H_2SO_4 vs. Na_2SO_4), and nitric (HNO_3 vs. $NaNO_3$) acids.

The most important reason to include hydrogen in the Metal Activity Series is because these acids are simple and convenient reagents which can quickly establish where an unknown metal stands in the series. For example, if a metal reacts with dilute HCl, then it is above hydrogen in the series. If it does not react with dilute HCl, then it lies below hydrogen in the series.