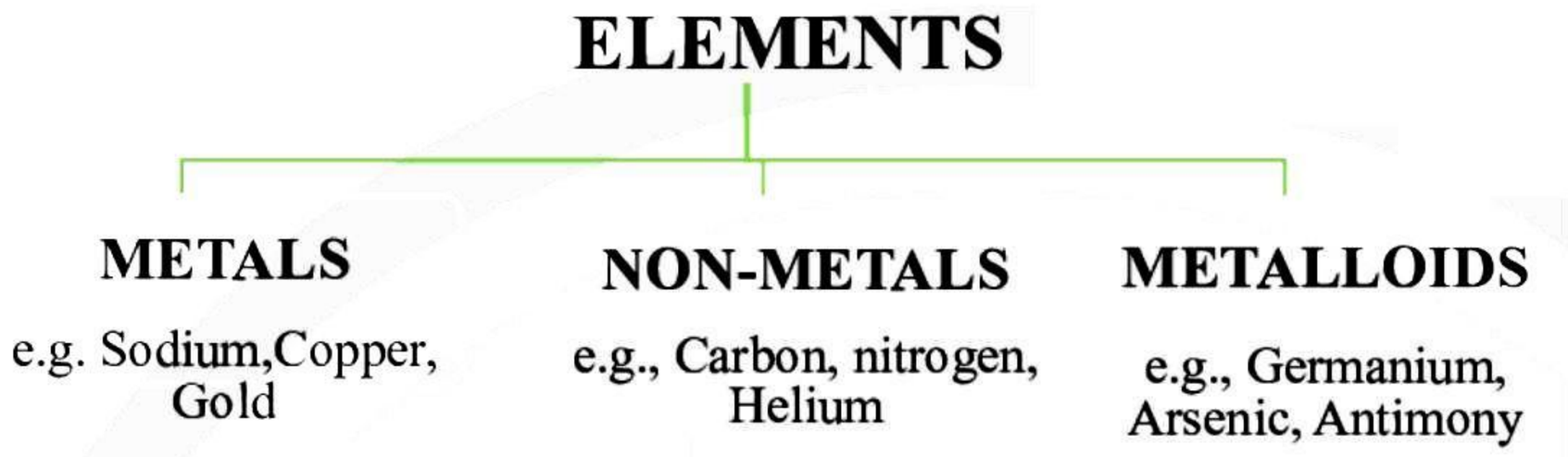
Metal and Non-Metals

CLASSIFICATION OF ELEMENTS

It was found that there was a wide variation in the properties of elements. Hence these were further classified into three categories, i.e. metals, non-metals, metalloids based on the properties they exhibit.



OCCURRENCE OF METALS AND NON-METALS

Non-Metal	Free State	Combined State
Nitrogen	78% of air by volume is nitrogen	In living organisms as proteins and in soil as nitrogen compounds
Carbon	As graphite, and Diamond	Metal carbonates, natural gas, petroleum, proteins, carbohydrates, fats and in air as carbon dioxide
Sulphur	Present inside the Earth's crust	Metal sulphides and metal sulphates

PHYSICAL PROPERTIES OF METALS AND NON-METALS

PROPERTY	METALS	NON-METALS
State:	Solids at room temperature. Exceptions: Hg and Ga are liquids	Mostly gases. Exception: Some of the solid non-metals are C,S,P,I_2 and bromine is a liquid non-metal.
Melting point and boiling point:	Very high melting point and boiling point. Exceptions: Na, K, Hg have low melting points and boiling points. Ga has low melting point but high boiling point.	Low melting points and boiling points. Exceptions: C, Si and B have high melting points and boiling points.

Hardness:	Generally hard. Exceptions: Na and K are soft.	Solid non-metals are brittle. Exception: Diamond is the hardest naturally occurring substance.
Density:	Have high density. Exception: Li, Na and K have density lower than water (1gm/cm^3)	Have low density. Exception: Diamond
Conductivity:	Good conductors of heat and electricity. Exceptions: Bi and W are poor conductors of electricity.	Bad Conductors of heat and electricity. Exception: Graphite and gas carbon are good conductors of electricity.
Lustre:	Have lustre	No lustre. Exceptions: I_2 and graphite.
Tensile strength;	High tensile strength Exception: Zn has very less tensile strength.	Do not have tensile strength. Exception: Carbon fibre, a recently developed allotrope of carbon.
Malleability and ductility:	Generally malleable and ductile. Exception: Zinc is not malleable and ductile.	Non-malleable and non-ductile. Exception: Carbon fibres are ductile
Sonority	Sonorous	Non-sonorous

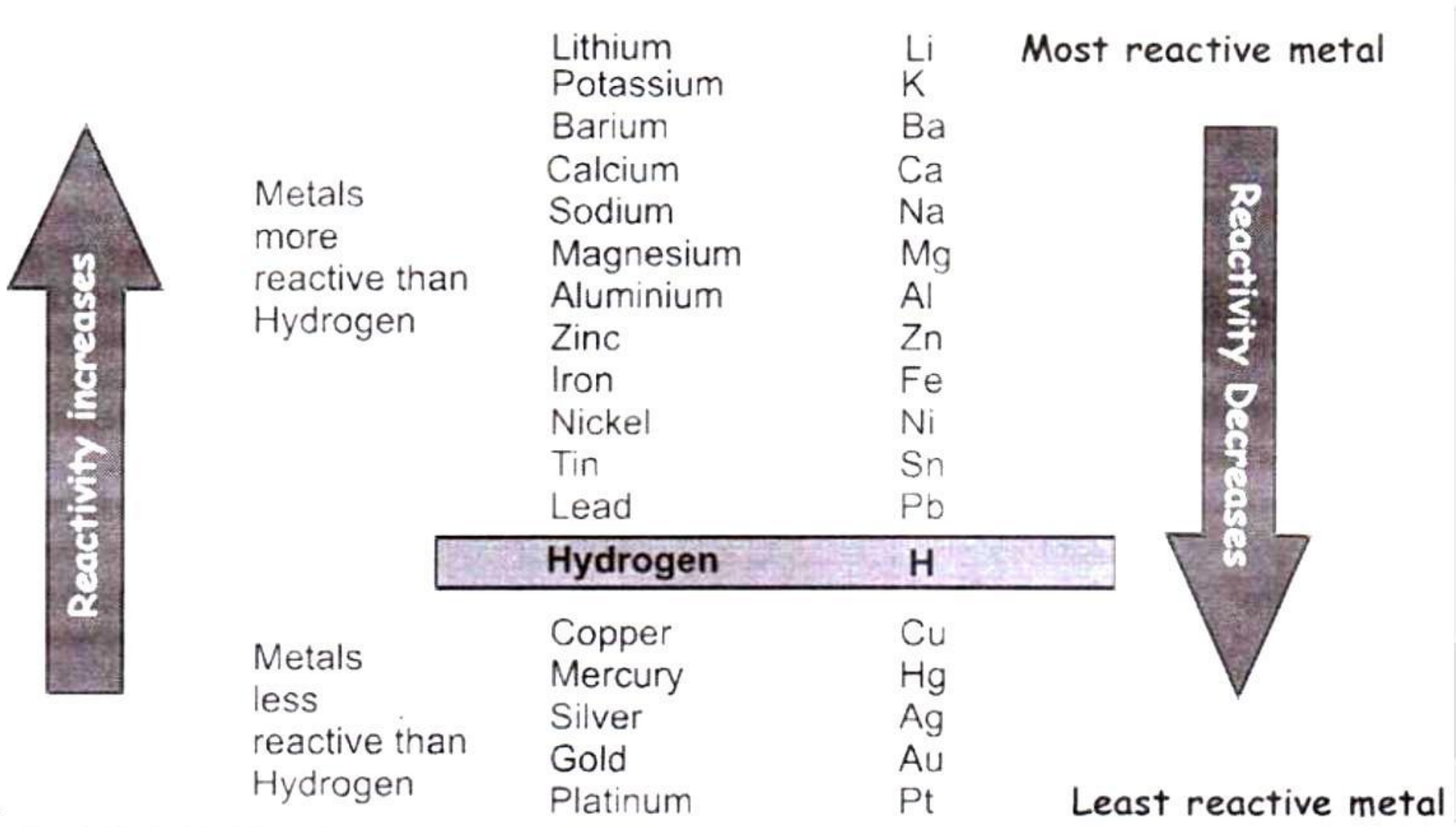
CHEMICAL PROPERTIES OF METALS AND NON-METALS

PROPERTY	METAL	NON-METAL
Number of electrons in the valence shell:	Have 1 to 3 electrons in their valence shells.	Have 4 to 7 electrons in their valence shells. Exceptions: Hydrogen has one electron in its valence shell because the first shell is its valence shell.
Formation of ions:	Lose electrons from their valence shells to attain stable structures and form Cations	Accept electrons to attain stable structures and form Anions.
Reaction with oxygen		

	Metals on heating in air or oxygen react to form their respective oxides. **Metal + Oxygen → Metal Oxide** The oxides are either basic or amphoteric in nature. Exceptions: Metals like Au and Pt do not form oxides. Examples $4Na + O_2 \rightarrow 2Na_2O$ $4K + O_2 \rightarrow 2K_2O$ $2Ca + O_2 \rightarrow 2CaO$	Non-metals on heating in air or oxygen form their respective oxides. **Non-Metal + O_2→Non-Metal Oxide** The oxides are either acidic or neutral in nature. Examples $C + O_2 \rightarrow CO_2\uparrow$ $S + O_2 \rightarrow SO_2\uparrow$ $P_4 + 5O_2 \rightarrow 2P_2O_5\uparrow$
Reaction with Acid	Metals, which are more reactive than hydrogen, replace hydrogen from the acid **Metal + Dil. Acid → Salt + $H_2\uparrow$**	The majority of non-metals do not react with acids.
Reaction with Water	Metals, which are more reactive than hydrogen, reacts with water and removes hydrogen and forms metal hydroxide or Metals Oxide **Metal + H_2O→ Metal Oxide + $H_2\uparrow$** **Metal + H_2O→ Metal hydroxide + $H_2\uparrow$**	Non-metals react with water in various ways
Reaction With Cl_2	Metals react with chlorine to form metal chloride salts Example: $2Na + Cl_2 \rightarrow 2NaCl$ $Mg + Cl_2 \rightarrow MgCl_2$	Non-metals react with chlorine to form compounds which are either volatile liquids or gases Example: $H_2 + Cl_2 \rightarrow 2HCl$ $P_4 + 10Cl_2 \rightarrow 4PCl_5$
Electrolysis	Metals are generally liberated at cathode during electrolysis	Non-metals are generally liberated at anode during electrolysis
Oxidation/Reduction	Metals are good reducing as they readily lose electrons	Non-metals are good oxidising agents as they readily gain electrons.

REACTIVITY SERIES OF METALS:

The arrangement of metals in the order of decreasing reactivates is called the reactivity series or activity series of metals.



CORROSION OF METALS

Corrosion is a process of deterioration of metal as a result of its reaction with air or water (present in environment) surrounding it.

RUSTING OF IRON:

The slow conversion of iron into its hydrated oxide, in the presence of moisture and air is called rusting, whereas the hydrated oxide of iron is called rust.

$$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$$

Iron Oxygen Ferric oxide

$$Fe_2O_3 + xH_2O \longrightarrow Fe_2O_3.xH_2O$$

Ferric Oxide Water Hydrated ferric oxide

The brownish residue ($Fe_2O_3.xH_2O$) is commonly called rust and the phenomenon is called rusting. The rust so formed is flaky and easily crumbles from the surface of metal. Thus, fresh iron is exposed to the attack of moist air, to form more rust.

METALLOIDS

An element that has a property of metal and non-metal both are known as Amphoteric elements or Metalloids.

For Example

Element	Metallic Property	Non-Metallic Property
Germanium	It acts as a semiconductor with rise in temperature.	GeO_2 is acidic in nature.
Arsenic	Metallic grey arsenic is a fair conductor of electricity.	Yellow arsenic forms hydride. (AsH_3), a weak base.
Antimony		

	Grey coloured antimony conducts electricity	Yellow antimony forms stibine. (SbH_3), a weak base.

ALLOYS

A homogeneous mixture of two or more molten metal (or a non – metal) is called alloy. Pure metals generally do not have all the properties of a good metal, such as malleability, ductility, tensile strength, hardness, resistance to corrosion, conduction of heat and electricity, etc.

However, one or more of these properties can be improved by melting two or more metals (or non – metal) in some fixed proportion and then allowing the molten product to cool at room temperature. Such a product is called an alloy.

OBJECTIVE OF ALLOY MAKING

Alloys are generally prepared to have certain specific properties which are not possessed by the constituent metals. The main objects of alloy-making are:

- To increase chemical reactivity.
- To modify chemical reactivity.
- To increase the hardness.
- To increase tensile strength.
- To produce good casting.
- To lower the melting poi

Name of alloy	Principal Metal	Composition	Properties	Uses
Duralumin	Aluminium	Al = 95% Cu = 4% Mn = 0.5%, Mg = 0.5%	Light weight and as strong as steel.	Aircraft frames, rockets, speed boats, automobiles.
Magnalium	Aluminium	Al = 95% Mg = 5%	Light weight, strong resists corrosion.	Used for making aero planes, household appliances, mirrors and scientific instruments.
Stainless Steel	Iron	Fe = 83% C = 1% Cr = 15% Ni = 1%	Resists corrosion	For making utensils, cutlery, surgical instruments and ornamental pieces.
Manganese steel	Iron	Fe = 84% Mn = 15% C = 1%	Very tough and hard.	Used for making safes, amour rock cutters etc.
Tungsten Steel	Iron	Fe = 79-84% W = 15-20% C = 1%	Very-very hard.	Used for making high speed tools.
Aluminum Bronze	Copper	Cu = 90% Al = 10%	Golden yellow in colour. Durable and resistant to corrosion.	Used for making artificial jewellery, coins, picture frames etc.
Brass	Copper	Zn = 20-40% Cu = 60-80%	Lustrous, more malleable and ductile than copper.	Used for making shells of ammunition rounds, utensils, electric switches, statues, etc.
Bronze	Copper	Cu = 80% Zn = 10% Sn = 10%	Hard but brittle, resistant to corrosion. Takes very high polish.	Used for making shells, statues, coins and utensils.
Gun Metal	Copper	Cu = 88% Sn = 10% Zn = 1% Pb = 1%	Very hard, gives a very good cast.	Used for making barrels of guns, gears and bearings.
German Silver	Copper	Cu = 60% Zn = 30% Ni = 10%	As white as silver, malleable and ductile.	Used for making imitation silver jewellery, utensils, etc.
Bell Metal	Copper	Cu = 80% Sn = 20%	Hard and brittle, produces with sonorous sound.	Used for making bells and gongs.
Monel Metal	Nickel	Cu = 28% Ni = 67% Fe = 5%	Resistant to corrosion, malleable and ductile.	Used for making sinks, doors and windows screws.