Metals And Non-Metals

Metals

Those elements having 1,2,3 electrons in their outermost orbit and forming electropositive ions (cations) by losing electrons called Metals.

e.g. $Na(11) - 2,8,1 \longrightarrow Na^{+}$
$Mg\ (12) - 2,8,2 \longrightarrow Mg^{2+}$
$Al\ (13) - 2,8,3 \longrightarrow Al^{3+}$

Non-metals

Those elements having 5,6,7 electrons in their outermost orbit and forming electronegative ions (anions) by gaining electrons called non-metals.

e.g. $Cl\ (17) - 2,8,7 \longrightarrow Cl^{-}$

Metaloids

Those elements having both the properties of metals as well as non-metals and having valency 4 called Metaloids.

e.g. Boron, Silicon, Germanium, Arsenic, Antimony etc
$Si\ (14) - 2,8,4$.

Noble gases (Inert gases)

Those elements are chemically stable i.e their outermost orbit is completely filled called Noble gases.

e.g. $He\ (2) \rightarrow 2$
$Ne\ (10) \rightarrow 2,8$
$Ar\ (18) \rightarrow 2,8,8$
$Kr\ (36) \rightarrow 2,8,18,8$
$Xe\ (54) \rightarrow 2,8,18,18,8$
$Rn\ (86) \rightarrow 2,8,18,32,18,8$

Metal...

Metal...

[Physical properties]

- Metals p... metalic ... lead (Pb...
- Most of ... hard and ... except ... which ca... by knife...
- Metals p... melting ... point ... Galium, ... K.
- Metals a... ductile ... into wi... Zn, Hg...
- Metals a... mallea... into sh... Zn and ...
- Metals a... not britt... Zn.
- Good cond... heat & e... except Tu...

Metals & Non-Metals (Differences)

[Physical properties]

Metals	Non-metals
• Metals possess high metalic lustere except lead (Pb).	Non-metals having dull appearance except I and graphite (C)
• Most of the metals are hard and strong except Na and K. which can be cut by knife also	Non-metals having three forms, solid, liquid as well as gases. solid - S, C and P. liquid - Br (Bromine) gas - H_2, O_2, Cl_2, N_2, etc.
• Metals possess high melting and boiling point except Galium, Hg, Na, K.	The melting point and boiling point of non metals are very low except C, B, Si
• Metals are usually ductile (drawn into wires) except Zn, Hg and Ga.	Non-metals are non-ductile except C (carbon fibres used to transmit electric signals.
• Metals are usually malleable (beaten into sheet) except Zn and Hg.	Non-metals are non-malleable they break into pieces when beaten with hammer.
• Metals are hard but not brittle except Zn.	Non-metals are generally brittle
• Good conductor of heat & electricity. except Tungsten.	Bad conductor of heat & electricity except Graphite.

• They forms alloys (homogenous mixture of two or more metals)	They do not form alloys except C and P
[Chemical properties]	
• Oxides of metals are usually basic. Example - Basic oxides Na_2O, CaO, MgO, Fe_2O_3, CuO Acidic oxides CrO_3, Mn_2O_7. Amphoteric oxides ZnO, Al_2O_3, PbO	Oxides of non-metals are usually acidic. Example - Acidic oxides CO_2, SO_2, SO_3, NO_2, P_2O_5 Neutral oxides CO, NO, N_2O, H_2O.
• Reaction with Hydride	Reaction with Hydride
Metals do not form hydride but if they form hydrides they are not very stable. Example - NaH, CaH_2	Non-metals form stable hydride. Example - NH_3, H_2O, CH_4
• Metals discharged at Cathode during electrolysis	Non-metals discharge at Anode during electrolysis.
• They form cations ~~by~~ by losing electrons	They form anaions by gaining electrions.

Activity series – The arrangement of metals in the decreasing order of their reactivity in the form of a series is called Activity series.

K	Zn	Hg
Na	Fe	Ag
Ca	Pb	Pt
Mg	[H]	Au.
Al	Cu	

Metallurgy – The process used for extraction of metals in their ~~fo~~ pure form from their ~~ear~~ Ores called Metallurgy.

Mineral – The natural occuring compounds which contain metals in the form of rocks called Minerals.

Example – Limestone etc.

Gangue (Matrix) – The impurities which is present in ore called Gangue or Matrix.

Ores – Those minerals from which metals are extracted commercially at a low cost with minimum effort called Ores.

~~Extraction~~ Metals	Name of the ore
K	Carnallite $(KCl \cdot MgCl_2 \cdot 6H_2O)$
Na	Rock salt $(NaCl)$
Ca	Limestone, Marbel $(CaCO_3,\ CaSO_4 \cdot 2H_2O)$
Mg	Carnallite, $MgCO_3$
Al	Bauxite $(Al_2O_3 \cdot 2H_2O)$ & Cryolite (Na_3AlF_6)

Zn	Zinc Blende (ZnS) and Calamine ($ZnCO_3$)
Fe	Haematite (Fe_2O_3), Magnetite (Fe_3O_4), Iron Pyrites (FeS_2)
Pb	Galena (PbS)
Cu	Copper Pyrite ($CuFeS_2$)
Hg	Cinnabar (HgS)
Ag	Argentite (Ag_2S), Horn Silver ($AgCl$)

Metallurgy - Under metallurgy there are four steps :-

i) Concentration of ores
ii) Conversion of ores into oxide ores
iii) Reduction
iv) Refining

Step 1 : Concentration of Ores

The process in which gangue particles are separated from ores is called concentration of ores. It involves four main methods :-

i) Hydraulic washing (gravity separation)

In this process we take a tank and water is poured into it and then powdered ore (oxide ore) mix into it. After stirring few time the heavier particles (ore particles) are settled at the bottom and the lighter particles (gangue) floats at the surface of water. The Principle ~~beh~~ involve in this method that ore particles and gangue particles having different densities.

ii) Froath Floatation Process

In this process Sulphide ores can be separated from gangue particles. In this process water is poured into a huge tank in which powdered ore mix into it. Pine oil also mix into it to make froath. Hot air pass through the hollow pipe to the solation. Since the sulphide ore is lighter in nature, it floats at the surface, and gangue particles settled at the bottom. The froath containing ore taken out and dried up to get the pure ore.

iii) Magnetic Separation

In this process iron ore can be separated from gangue. This process involve two rollers connected with a belt. The powdered ore dropped on the belt at the one end which moves with belt and reach to the ~~sol~~ roller contain magnet. The magnet attract the ores and the impurities separated from it.

iv) Chemical Separation (Bayer's Method)

In this method high active ores can be separated from its gangue particles. Few chemicals which on reaction with impure ore provides pure ore.

$$\underset{\text{Impure Alumina}}{Al_2O_3 \cdot 2H_2O} + 2NaOH \longrightarrow \underset{\text{Sodium Aluminate}}{\overset{2NaAlO_2}{\cancel{2NaAl_2}}} + 3H_2O$$

$$NaAlO_2 + 2H_2O \longrightarrow \underset{\text{Aluminium hydroxide}}{Al(OH)_3} \downarrow + NaOH$$

$$2Al(OH)_3 \xrightarrow[1000°C]{\Delta} \underset{\text{Pure Alumina}}{Al_2O_3} + 3H_2O$$

Step 2: Conversion of Ores into ~~*~~ oxide ores

Ores can be converted into oxide ore because the extraction of metal from oxide ore is cheaper and easier. It involves two methods :-

i) Calcination

ii) Roasting

Roasting	Calcination
• The ore is heated in excess of air.	The ore is heated in absence of air.
• Sulphide ores are generally used in this method. $2ZnS + 3O_2 \xrightarrow[800°C \text{ to } 900°C]{} 2ZnO + 2SO_2$	Carbonate and hydrated ores are used in this method. $ZnCO_3 \rightarrow ZnO + CO_2$ $Al_2O_3 \cdot 2H_2O \rightarrow Al_2O_3 + 2H_2O$
• Volatile impurities are removed as oxides (SO_2, P_2O_5) and ore becomes porous and more reactive.	Moisture and organic impurities are removed.

Step 3: Reduction

After converting ore into oxide ore, the oxygen present in it has to be removed to get pure metal. This process is called Reduction. It involves four steps:—

i) Those metals which are present in lower position in activity series can be obtained by direct heating.

Examples — $2HgO \xrightarrow{\Delta} 2Hg + O_2$

ii) Those metals which are at the middle of the activity series,

Examples — (Fe, Zn, Ni, Sn) cannot be reduced by direct heating. So they require a reducing agent.

$$ZnO + \underset{\substack{\text{reducing (coke)} \\ \text{agent}}}{\underline{C}} \longrightarrow Zn + CO$$

iii) Some metallic oxides cannot be reduced by using carbon as a reducing agent. Examples – (Mn, Fe, Cr) These can be reduced by using Aluminium as a reducing agent. This process is also known as Alumino Thermite Process. It is used to join the broken railway tracks because Aluminium reduce the melting point of Iron.

$$3MnO_2 + 4Al \longrightarrow 3Mn + 2Al_2O_3$$
$$Fe_2O_3 + 2Al \longrightarrow 2Fe + Al_2O_3 \quad (\text{Thermit reac}^n)$$
$$Cr_2O_3 + 2Al \longrightarrow 2Cr + Al_2O_3$$

iv) The reactive metals which are at the top of the activity series cannot be reduced by any other method because they have great affinity towards oxygen. So, these can be reduced by electrolytic ~~refining~~ reduction. In this process we take an electrolytic tank containing two metallic plates, one positively charge called anode and one negatively charge called cathode. The salt solution of the metal which can be reduced ~~of the metal~~ taken as Electrolytes. The electric current passed through the solution and positive and negative ions are separated into cathode and anode.

① $$2NaCl \xrightarrow[\text{Molten}]{} 2Na^+ + 2Cl^-$$

at Cathode

$$2Na^+ + 2e^- \longrightarrow 2Na$$

at anode

$$2Cl^- - 2e \longrightarrow Cl_2$$

(ii) $MgCl_2 \xrightarrow[\text{Molten}]{} Mg^{2+} + 2Cl^-$

at cathode

$$Mg^{2+} + 2e \longrightarrow Mg$$

at anode

$$2Cl^- - 2e \longrightarrow Cl_2$$

Step 4: Refining Of Ore

The metal obtained from ore is not ~~pure~~ 100% pure. It contains various impurities. So it must be refined before use.

i) Liquation

In this process we separate the metals having low melting points from the metals having high melting points.
Examples - Pb, Sn

ii) Electrolytic refining

This is the method widely used for all metals such as Al, Cu, Sn, Pb, Au. In this method the impure metal is made anode while pure metallic rod acts as cathode. A salt solution of metal acts as electrolyte. On passing the electric current the pure metal get deposited on the cathode. The more reactive impurities present in the metal remain in the solution and the less reactive impurities falls to the bottom of the electrolytic cell. The impure anode becomes thinner and thinner and the pure cathode becomes thicker and ~~thickne~~ thicker.

Alloy – It is a homogenous mixture of two or more metals or one metal or one non-metal.

Purposes of making alloys :–

i) To modify the appearance and the colour.
ii) To improve the chemical properties.
iii) To lower the melting point.
iv) To increase the hardness and tensile strength.
v) To increase resistence to electricity.

Alloy's name	Composition	Properties	Used for making
• Duralumine (Al)	(95%) Al, (4%) Cu, (0.5%) Mg, (0.5%) Mn	i) light but as strong as steel. ii) Hard and resistant to corossion iii) Highly ductile	i) Bodies of air craft and buses. ii) Pressure cooker and light tools.
• Magnalium (Al)	(90) to (95%) Al, (10) to (5%) Mg,	i) Resist to corossion ii) Light but strong.	i) Scientific instruments ii) Beam balance iii) Household appliances
• Alnico (Al)	Al, Ni, Co, Fe	i) light ii) Shiny iii) resist to corossion.	i) Used for making magnets.

Alloy's name	Composition	Properties	Used for making
• Stainless steel (Fe)	(73%)Fe, (18%)Cr, (8%)Ni, (1%)C	i) Resist to corossion ii) Lusturous iii) Resist to acids and alkalis	i) Making cutlery, surgical instruments and Utensils.
• Invar (Fe)	(63%) Fe, (36%) Ni, (1%) C	i) Negligible to expansion	i) Pendulum clocks and various scientific instruments
• Nickel steel (Fe)	(98%) Fe, (2%) Ni	i) Hard and elastic ii) Resistant to corossion	i) Used for making electric wire cables, automobile parts
• Brass (cu+zn)	(60) to (70%) Cu, (40) to (30%) Zn	i) Malleable and Ductile ii) Resist to corossion iii) Can be easily cast	i) Decorative hardware, screws and handles, electrical goods, parts of watches, musical instruments.
• Bronze (cu+zn)	(80%) Cu, (18%) Sn, (2%) Zn	i) Resist to corossion ii) Can be polished iii) Hard & easily cast	i) Making medals, statues, coins, bearings
• German silver (cu+zn)	(50%) Cu, (30%) Zn, (20%) Ni	i) White and light ii) Malleable and Ductile iii) High electrical resistance	i) Electric heaters, resistors, rheostat and ~~deco~~ decorative items.

Alloy's name	Composition	Properties	Used for making
• Gun metal ($Cu + Zn$)	(88%) Cu, (8%) Sn, (1%) Zn, (1%) Pb	i) Hard and brittle ii) Easy to cut	i) Making gears, bearings, barrels of cannons
• Solder or Fuse metal	Pb, Sn	i) Low melting point ii) High tensile strength	i) Welding purpose ii) Making fuse wires.

Q. Give an example of the following.

i) A metal liquid at room temperature.
→ Mercury (Hg)

ii) Can be easily cut with a knife.
→ Sodium (Na) & Pottassium (K)

iii) Best conductor of heat.
→ Silver (Ag)

iv) Poor conductor of heat.
→ Lead (Pb)

Q. why is Sodium kept immersed in kerosine oil?

→ Sodium is highly reactive metal. It can react very fast with oxygen from air. To protect it from reaction, it is stored in kerosene oil.

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Q. Give

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Q. Why do ionic compounds have high melting points ?

→ In ionic compounds, strong electrostatic forces of attraction are present between the oppositely charged ions. When these compounds are heated, a lot of heat is consumed to break the force of attraction during melting. Therefore, ionic compounds have high melting and boiling points.

Q. Give reasons :-

i) Platinum, Gold and Silver are used to make jewellery.

→ Platinum, Gold and Silver are least reactive metal which are also called Nobel metals. They are not corroded by air and water. So, they are used to make jewellery.

ii) Aluminium is highly reactive metal yet it is ~~~~ used to make utensils for cooking.

→ A thin layer of Aluminium Oxide (Al_2O_3) form on the surface of Aluminium, prevents it from corrosion. Thus, Aluminium vessels do not react with any ingredient of food and are suitable for cooking.

iii) What is Aquaregia ?

→ It is the mixture of HCl and ~~form~~ conc HNO_3 in the ratio