

4.4 CHEMICAL CHANGES

- a) Atomic Structure
- b) Periodic Table
- c) Structure and Bonding
- d) Quantitative Chemistry
- e) Chemical Changes
- f) Energy Changes

- Reactivity of Metals
- Reactivity Series
- Extraction of Metals
- Acids and Bases
- Neutralization
- Making Soluble Salts
- Making Insoluble Salts
- Titration
- Electrolysis
- Electrolysis of molten compounds
- Electrolysis of aqueous solutions
- Electrolysis of Aluminium

REACTIVITY SERIES



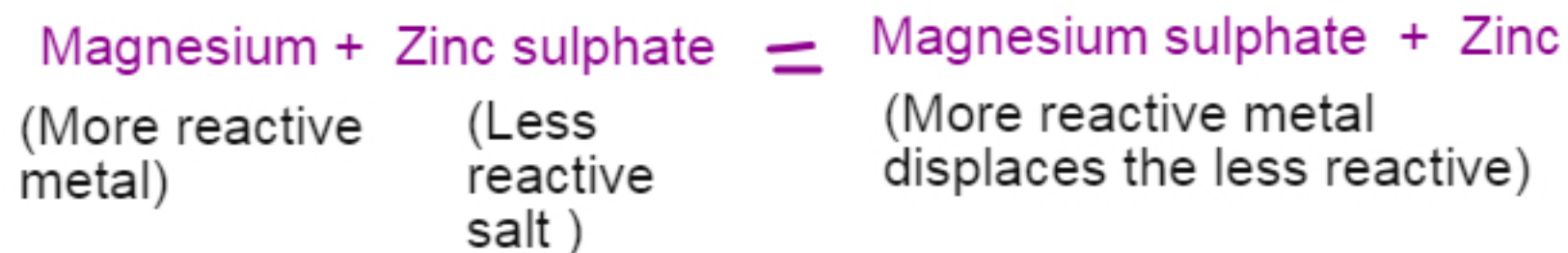
React with Acid
and displace
Hydrogen *Water*

Does not
react with acids
or water

| Most Reactive | |
|----------------|------------------|
| POTASSIUM | ¹⁹ K |
| SODIUM | ¹¹ Na |
| CALCIUM | ²⁰ Ca |
| MAGNESIUM | ¹² Mg |
| ALUMINUM | ¹³ Al |
| CARBON | ⁶ C |
| ZINC | ³⁰ Zn |
| IRON | ²⁶ Fe |
| TIN | ⁵⁰ Sn |
| LEAD | ⁸² Pb |
| HYDROGEN | ¹ H |
| COPPER | ²⁹ Cu |
| SILVER | ⁴⁷ Ag |
| GOLD | ⁷⁹ Au |
| PLATINUM | ⁷⁸ Pt |
| Least Reactive | |

DISPLACEMENT REACTION

More reactive metal will displace the less reactive metal from its salt solution.



(Less reactive metal cannot displace the more reactive metal)

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METAL EXTRACTION

MINERALS

Minerals are the rocks which contains metal.

ROCKS

Rocks are the minerals from which metals can be extracted profitably.

REDUCTION OF METAL OXIDES

Since most of the metals exist in the form of oxides, they can be extracted by reducing the ore.

By HYDROGEN

All the metal below hydrogen can be reduced by hydrogen

BY CARBON

All metal below carbon can be extracted by carbon

BY ELECTROLYSIS

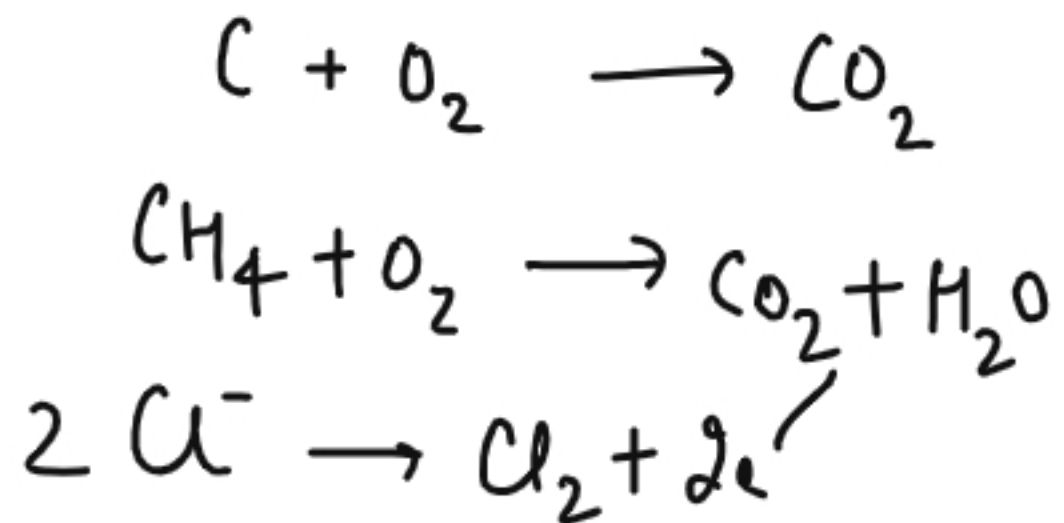
Metals that are above carbon and hydrogen will be extract by Electrolysis

OXIDATION AND REDUCTION

Gain of Oxygen

Loss Of hydrogen

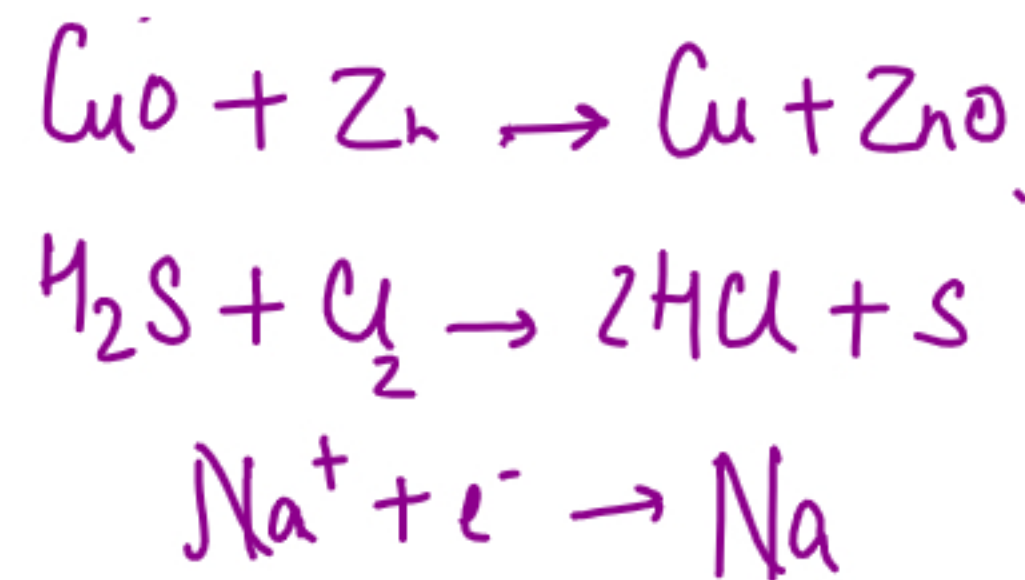
Loss of electrons



Loss Of Oxygen

Gain of Hydrogen

Gain of electrons





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Copper Oxide + Hydrogen \rightarrow Copper + Water



Zinc Oxide + Carbon \rightarrow Zinc + Carbon Dioxide



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Extracted
by electrolysis

Will be extracted
by carbon.

Will be
extracted
by Hydrogen.

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| Least Reactive | |

ACIDS , BASES and ALKALI

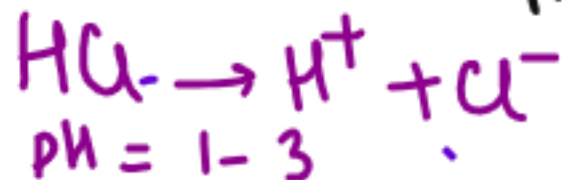
The substance which have pH less than 7

The substance which have pH greater than 7.

Strong Acids

They are completely dissociated in water to release H⁺ ions

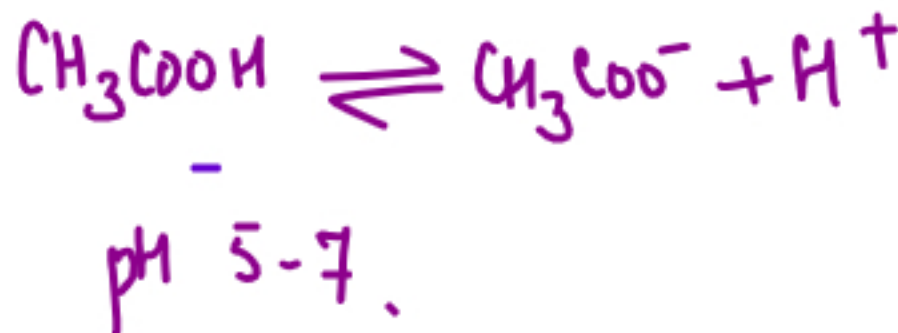
Hydrochloric Acid - HCl
Sulphuric Acid - H₂SO₄
Nitric Acid - HNO₃
Phosphoric Acid - H₃PO₄



Weak Acids

They are partially dissociated in water to released H⁺ ions

Vinegar: Ethanoic Acid
Lemon: Citric Acid



Metal Oxides, Metal Hydroxides
Metal Carbonates

Lithium Oxide, Lithium Carbonate,
Lithium Hydroxide

Alkali are the soluble bases. So bases that can dissolve in water.

eg- Alkali metal hydroxide

They release hydroxide ions when dissolved in water.



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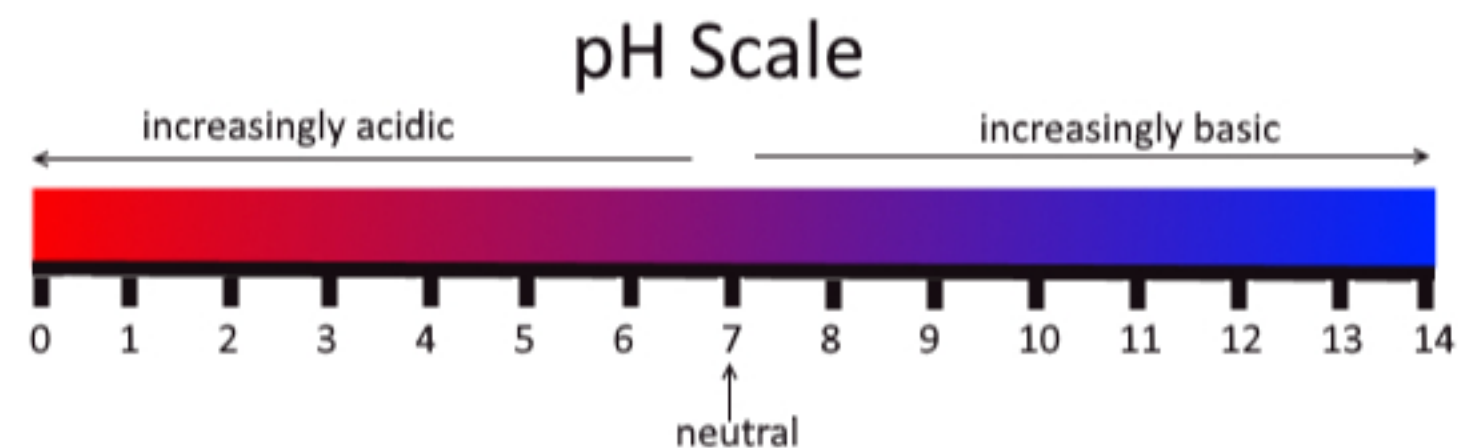
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INDICATORS

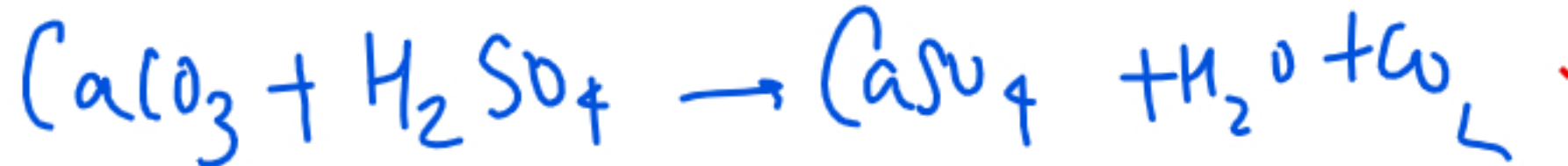
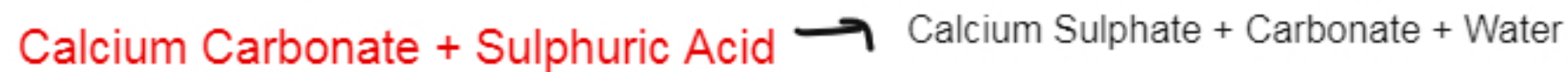
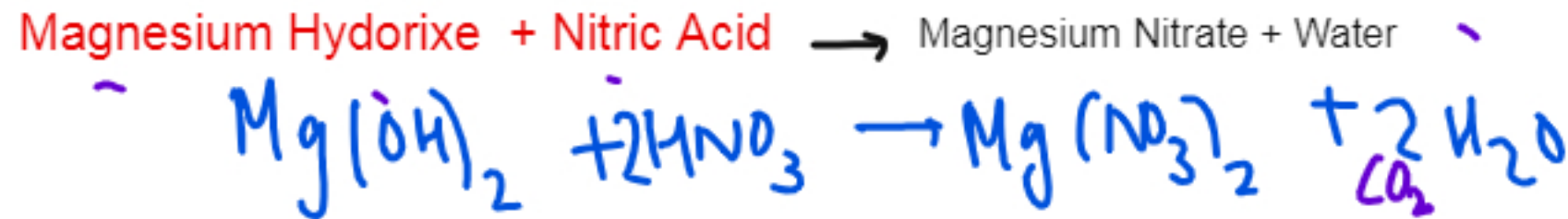
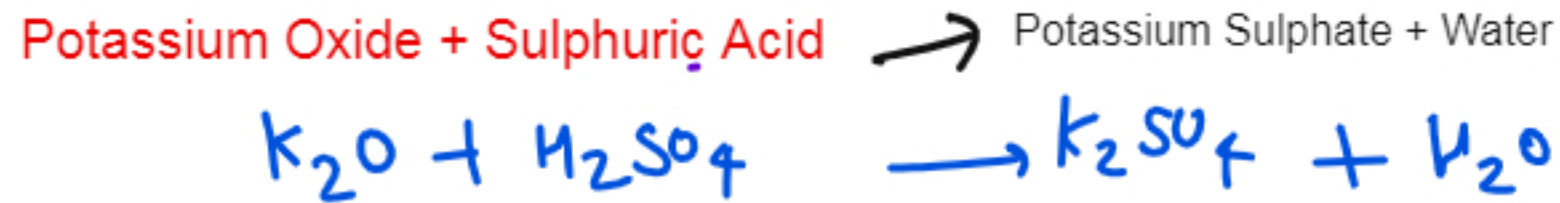
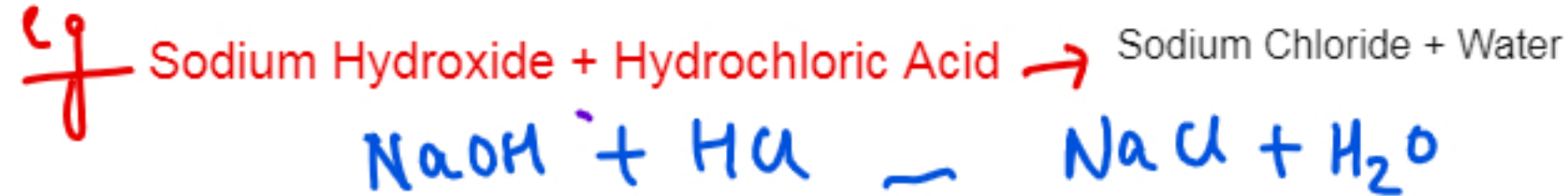
| Acids | Bases |
|--|-----------------------------|
| pH less than 7 | pH greater than 7 |
| Taste Sour | Taste Bitter |
| Not soapy | Feels soapy |
| have pungent smell | do not have a pungent smell |
| When ionize give hydrogen ions | Give hydroxide ions |
| Turns blue litmus red | Turns red litmus Blue |
| eg Hydrochloric Acid Sulphuric Acid | eg Sodium Hydroxide |



Universal Indicator



NEUTRALIZATION REACTION



- Acid**
- \longrightarrow Hydrochloric Acid
makes chloride salt
 - \longrightarrow Sulphuric Acid
makes sulphate salt
 - \longrightarrow Nitric Acid
makes nitrate salt

REACTIONS OF ACIDS

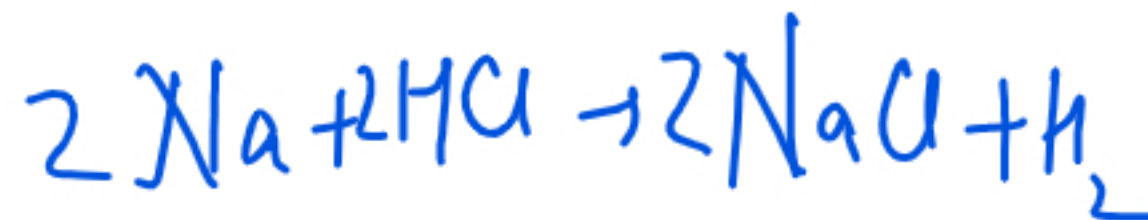
Metal + Acid = Salt + Hydrogen

Metal Oxide + Acid = Salt + Water


Metal Hydroxide + Acid = Salt + Water

Metal Carbonate + Acid = Salt + Water

+ CO₂



Making Insoluble salts



| | |
|---|---|
| Na ⁺ , K ⁺ , NH ₄ ⁺ salts | All soluble |
| Nitrates – NO ₃ ⁻ | All soluble |
| Chlorides, bromides, iodides – Cl ⁻ , Br ⁻ , I ⁻ | All soluble, except for Pb ²⁺ and Ag ⁺ |
| Sulfates – SO ₄ ²⁻ | All soluble, except for Pb ²⁺ , Ba ²⁺ , and Ca ²⁺ |
| Carbonates – CO ₃ ²⁻ | All insoluble, except for Na ⁺ , K ⁺ , and NH ₄ ⁺ |
| Hydroxides – OH ⁻ | All insoluble, except for Na ⁺ , K ⁺ , and NH ₄ ⁺ |

Source: Vimeo

Mix two soluble acids and Bases

The salt will come out as a precipitate

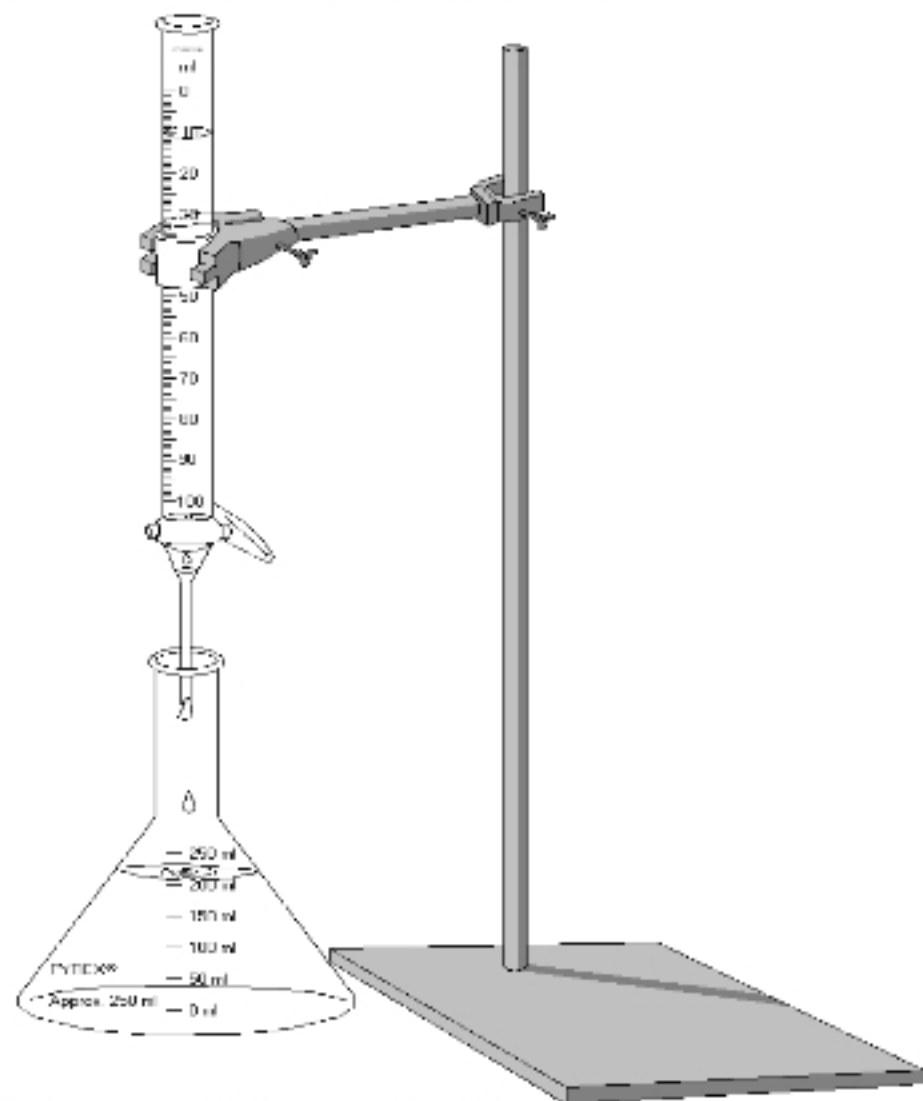
The precipitate is then filtered and dried.

The filter paper will contain an insoluble salt.

To determine the exact volume of acid and base required to make the salt, titration is carried out.

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Making Soluble Salts



Source: Wikimedia Commons

Mix the insoluble base into the aqueous solution of the acids.

Dissolve the base into the acid until no base can be dissolved.

filter the solution to remove excess undissolved base.

The run off is then crystallized to remove all the water.

After evaporation the crystals will collect at the size of the vessel.

The crystals can then be dried.

ELECTROLYSIS

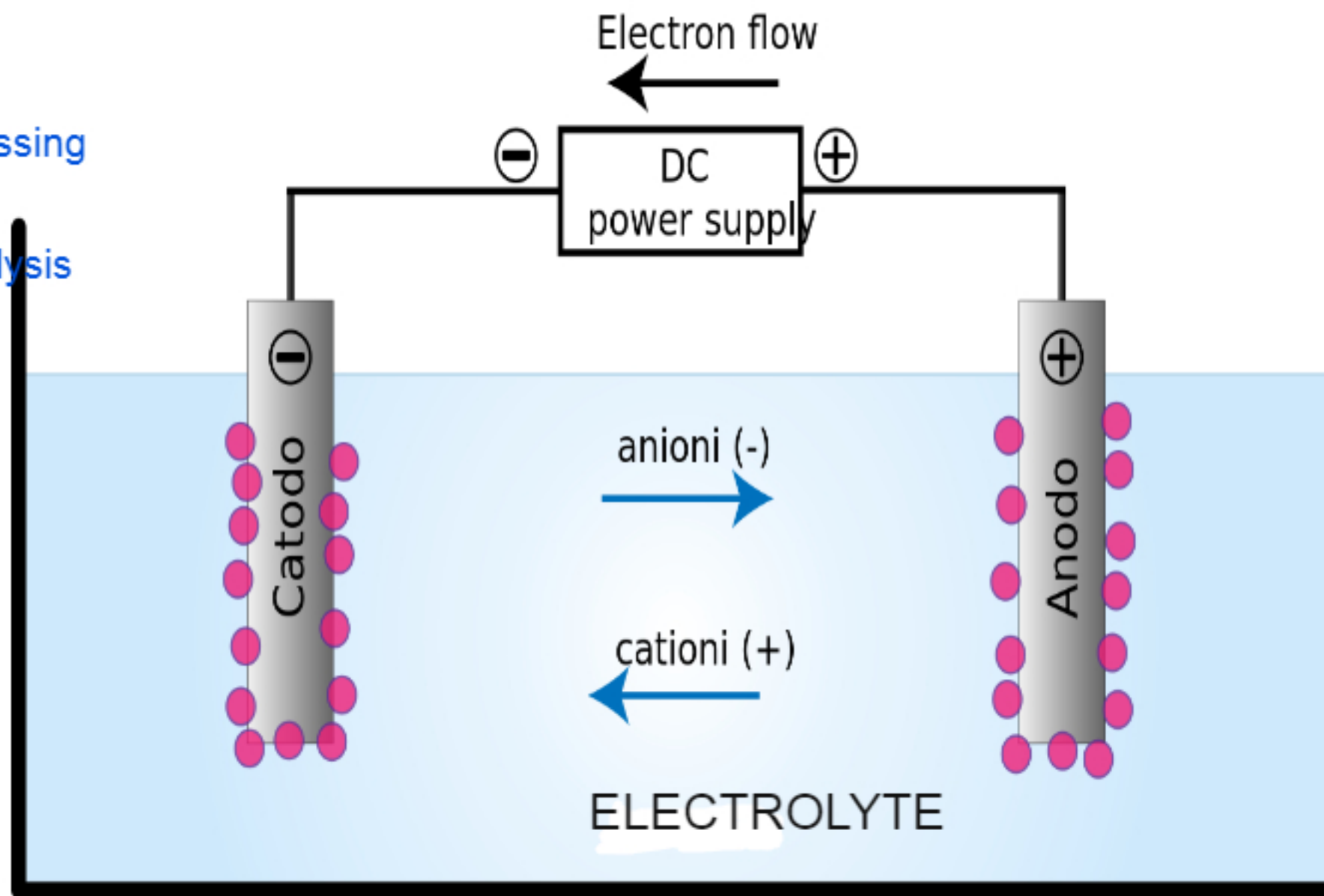
Electrolysis — The breaking of ionic compound by passing electricity.

Electrolyte — The substance that undergoes Electrolysis

Electrode — The two conducting rods dipped in an electrolyte

Cathode — Where Cations (+ve charge ions) go. So it is negatively charge electrode

Anions — Where anions (-ve charge ions) go. So it is positively charged.



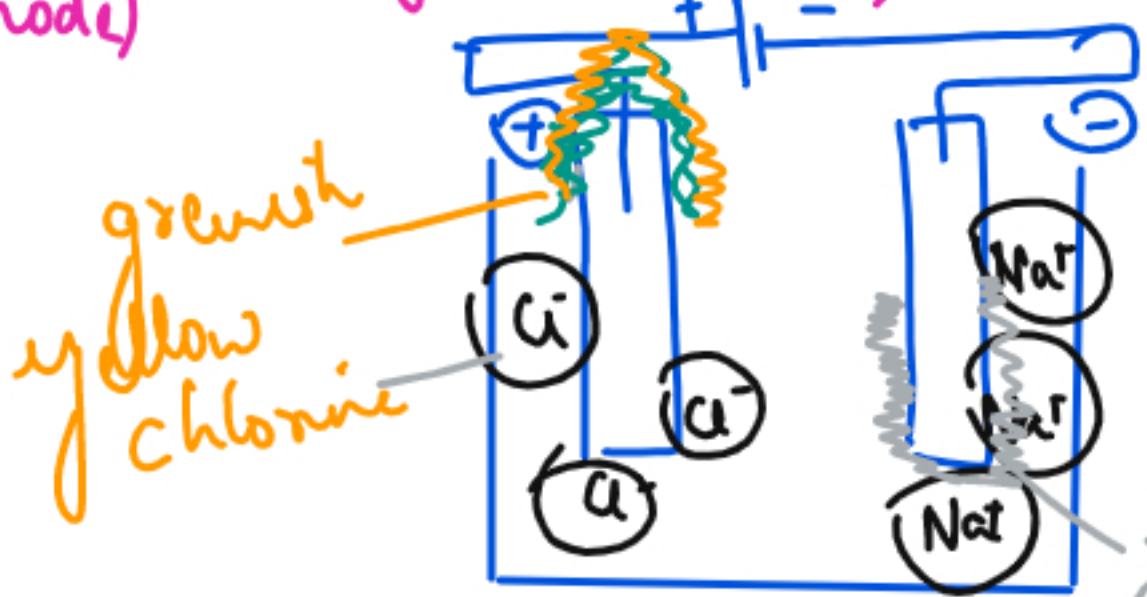
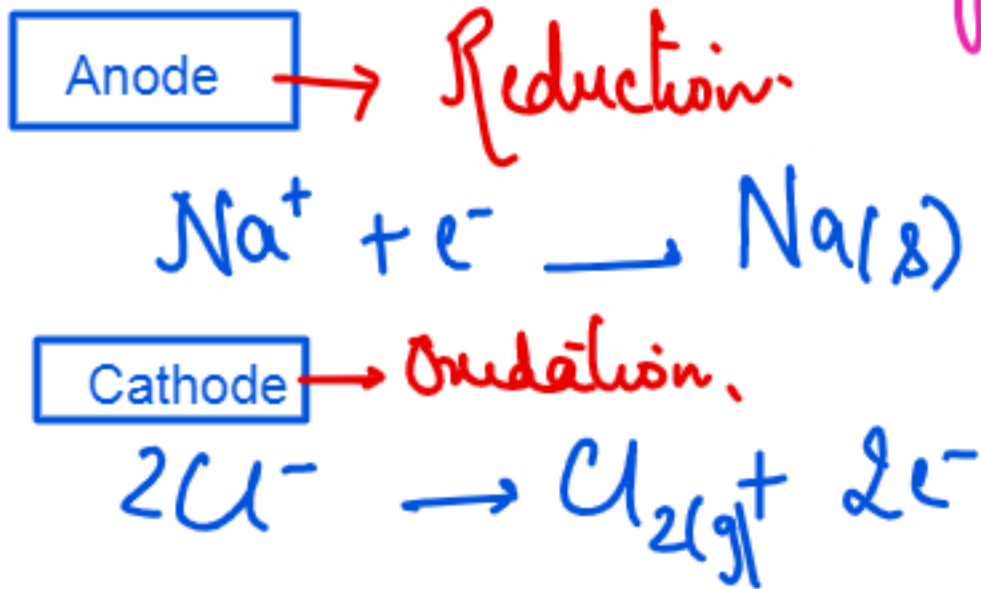
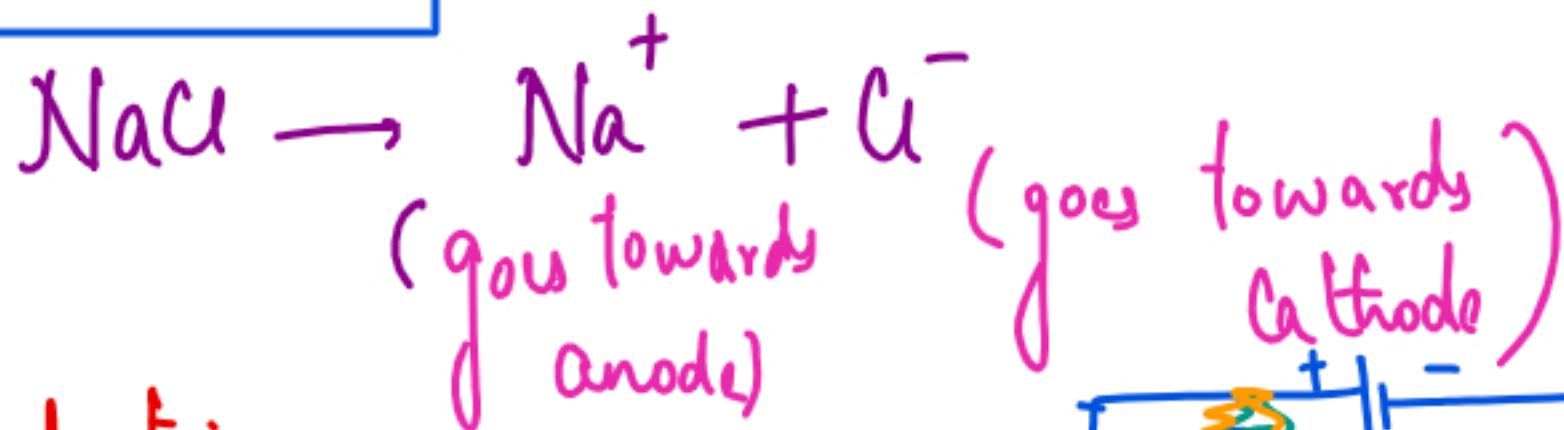
SOURCE: WIKIMEDIA COMMONS



ELECTROLYSIS OF MOLTEN IONIC COMPOUNDS

Ionic compounds conduct Electricity when in molten or in solution as the ions are free to move when they are in solvent or dissolved in water.

Molten Sodium Chloride

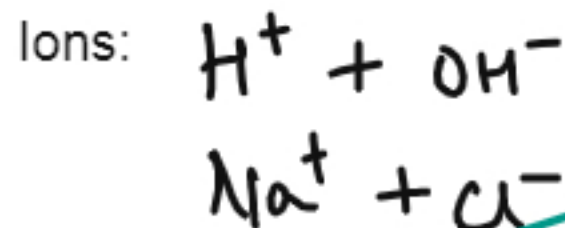


- O - Oxidation
- I - Is
- L - Loss
- R - Reduction
- I - Is
- G - Gain

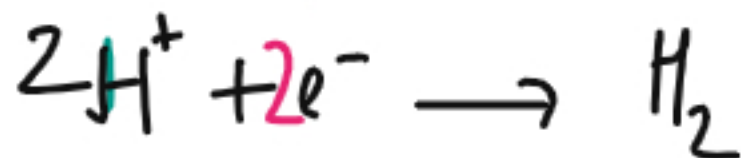
ELECTROLYSIS IN SOLUTIONS

In Solution the water also gets ionized and dissociate into H^+ and OH^- which also competes with the ionic compounds ions to discharge.

Sodium Chloride Solution



At Cathode



At Anode



Remaining Solution



Rule

At the cathode, the element with least reactivity will get discharged and gains electrons. For that we have to look at the reactivity series

For anode, the rules is :-
Halide > OH^- > other negative Ions.

Potassium Sulphate Solution



At Cathode



At Anode



Remaining Solution

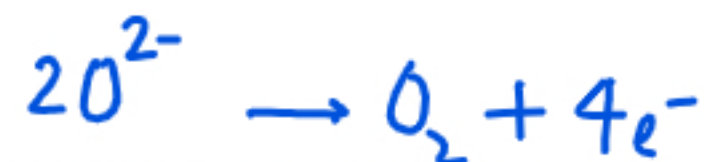




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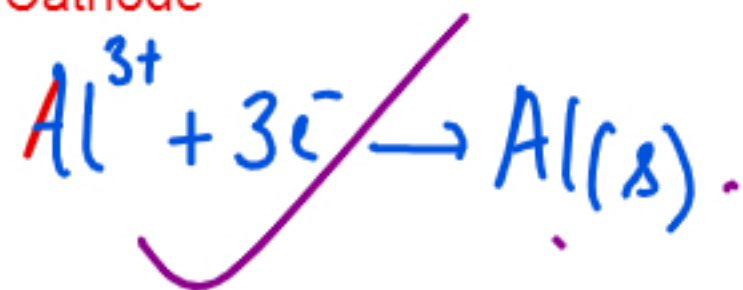
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At Anode



oxygen evolved reacts with graphite electrode forming carbon dioxide. Therefore they are used up and needs regular replacing

At Cathode



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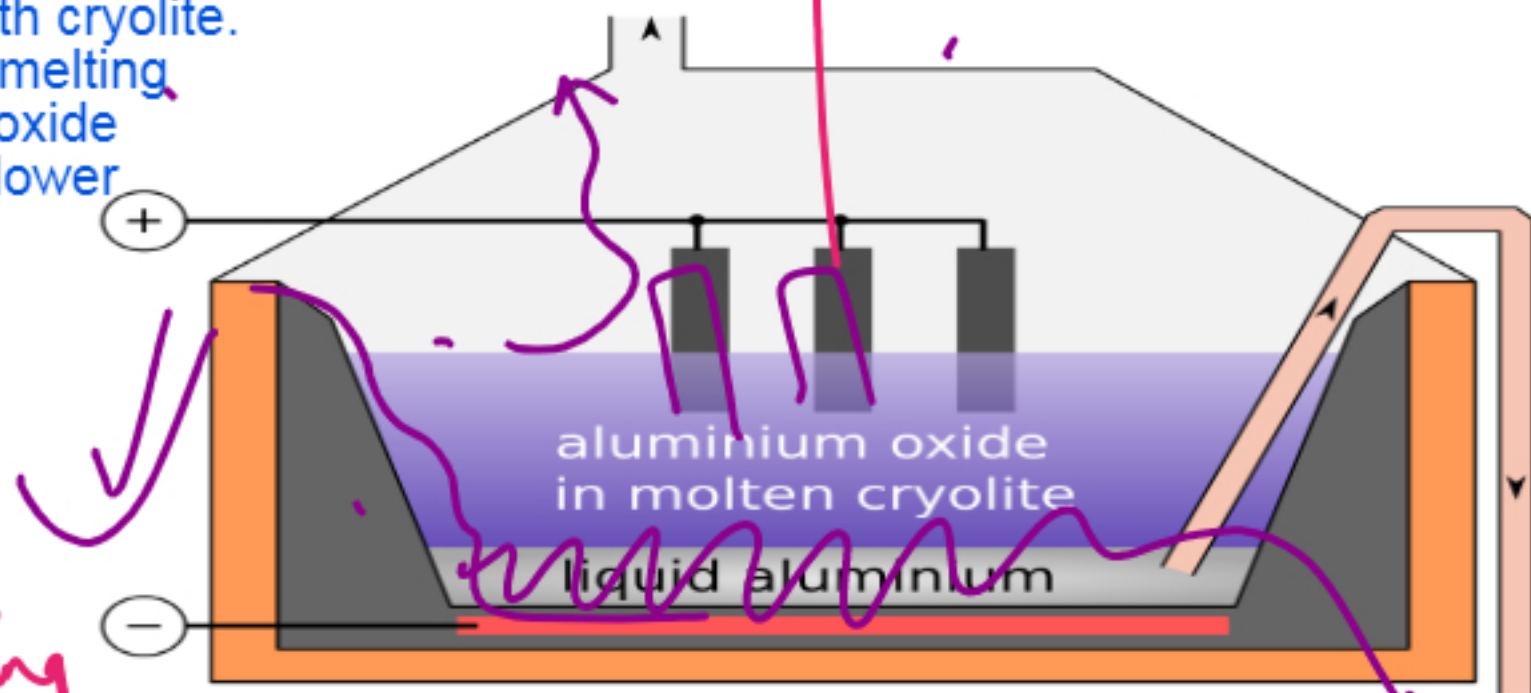
ELECTROLYSIS OF ALUMINIUM OXIDE

Bauxite an ore of aluminium is used which contains aluminium in the form of aluminium oxide.

Bauxite is mixed with cryolite. Cryolite lowers the melting point of aluminium oxide making it melt at a lower temperature.



(carbon lining as negative electrode)



Source: Wikimedia Commons



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Acids

Bases

Metals

Reactivity Series

Reduction

Oxidation

Alkali

Salt

Neutralization Reaction

Indicators

KEY TERMS

pH scale

Soluble Salts

Insoluble Salts

Electrolysis

Electrode

Anode

Cathode

Electrolyte

Ionic compounds

Cryolite

Bauxite

Ore

Metal Extraction

TEST

YOURSELF

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