



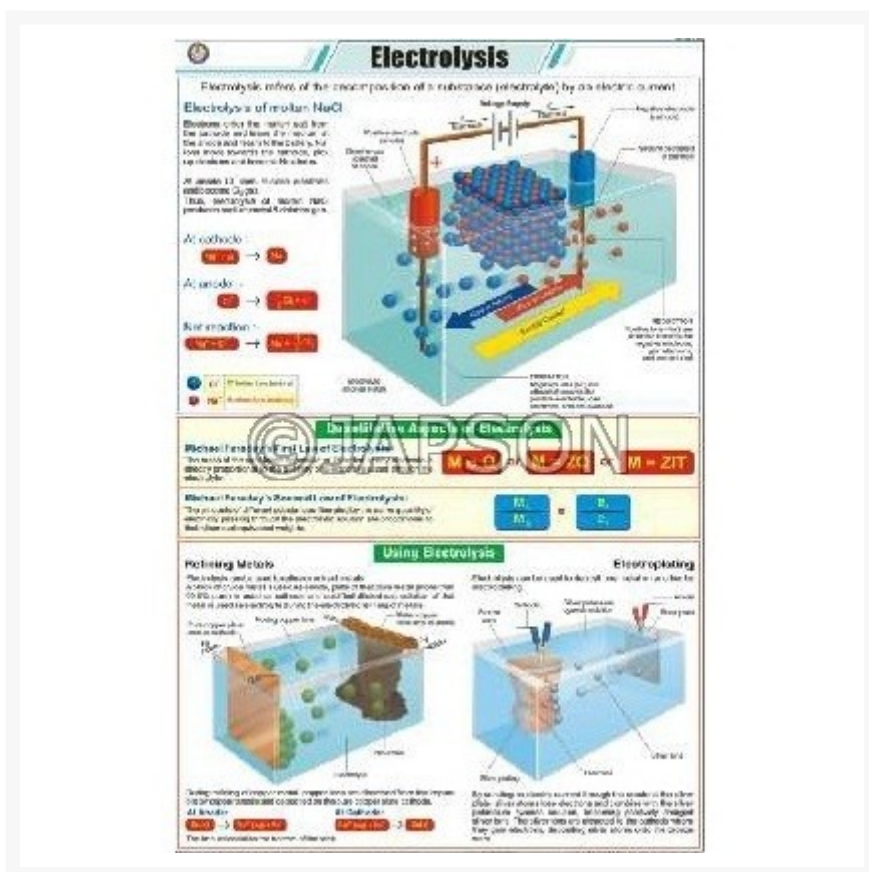
Address:
JAMBU PERSHAD & SONS
6275/22 Nicholson Road,
Ambala Cantt, Haryana,
INDIA
Pin: 133001

Email:
sales@japson.com
japsonambala@yahoo.com

Website:
www.japson.com
Phone:
+91-171-4006897

Chemistry (III) Charts, School Education

Product Image



Description

Standard Size: 58x90cms

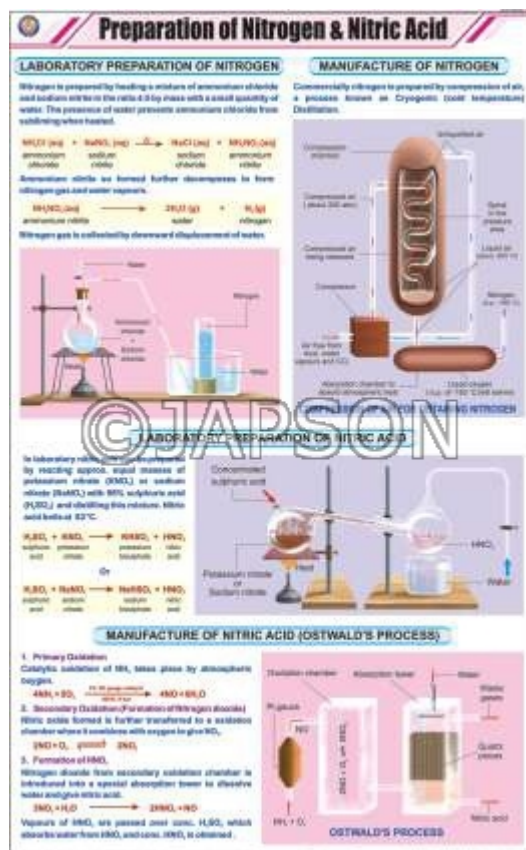
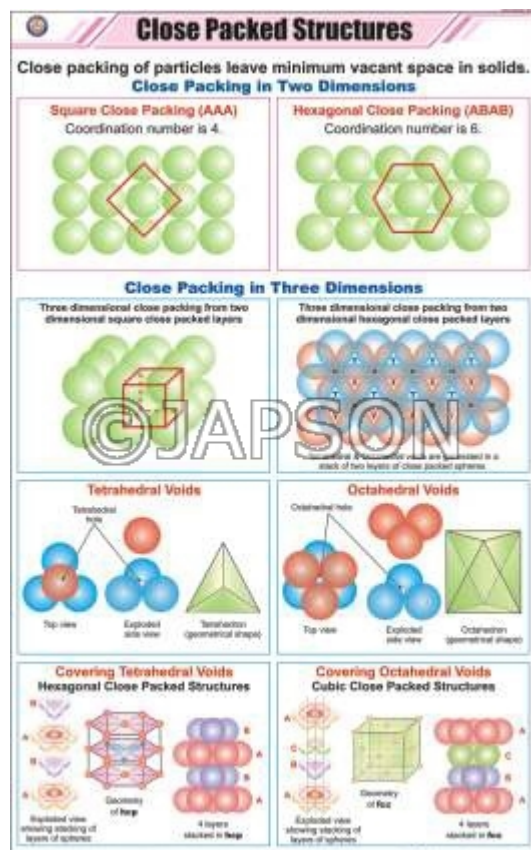
Language: English

Laminated Paper Charts with Plastic Rollers. These Charts have technically accurate and detailed description in vivid colours.

Note: Based on minimum order quantity conditions, Charts can be customized to your requirements in terms of CONTENT, LANGUAGE, SIZE, etc. Please write back to us for discussion.

A. Charts, Close-Packed Structure

B. Charts, Preparation of Nitrogen & Nitric Acid



C. Charts, Manufacture of Phosphorus

D. Charts, Manufacture of Bleaching Powder

Manufacture of Phosphorus

Production of White Phosphorus

Phosphate rock is heated to 1200-1500°C with sand and coke to produce vaporized P_4 , which is subsequently condensed into a white powder under water.

The main reactions involved are:-

$$Ca_3(PO_4)_2 + SiO_2 \rightleftharpoons 3CaO + SiO_2 + 2P_4$$

$$SiO_2 + SiC \rightleftharpoons SiCO + SiC$$

$$Ca_3(PO_4)_2 + SiC \rightleftharpoons 3CaO + SiO_2 + 2P_4$$

Reduct acts as a flux, converting CaO formed into slag.

$$CaO + SiO_2 \longrightarrow CaSiO_3 \text{ (slag)}$$

Converting White Phosphorus into Red Phosphorus

Red phosphorus is formed by heating white phosphorus to 250°C.

Manufacture of Bleaching Powder

Bleaching powder is a dirty white amorphous solid with a pungent smell of chlorine.

CHEMICAL COMPOSITION

Bleaching powder is actually a mixture of Calcium Hypochlorite, Calcium Chloride, Water and some Slaked Lime.

$$\text{Ca(OCl)}_2 \cdot \text{CaCl}_2 \cdot \text{Ca(OH)}_2 \cdot 2\text{H}_2\text{O}$$

INDUSTRIAL PRODUCTION

On industrial scale, it is manufactured in Hasclevler Plant or in Bachmann's Plant.

Raw Materials

1. Slaked Lime
2. Chlorine Gas

Reactions Involved

$$2\text{Ca(OH)}_2 + 2\text{Cl}_2 \uparrow \rightarrow \text{Ca(OCl)}_2 + \text{CaCl}_2 + 2\text{H}_2\text{O}$$

Slaked Lime
Chlorine
Calcium Hypochlorite
Calcium Chloride
Water

Manufacture of Bleaching Powder - HASENCLEVER PLANT

The plant consists of a number of horizontal cylinders provided with mixing shafts with blades. Slaked lime is dropped into the slanted cylinder. The chlorine gas is introduced into the second cylinder. Chlorine gas is introduced into the bottom of the tower. The counter currents allow a thorough mixing of the raw materials and complete conversion into bleaching powder.

The diagram illustrates the Hasclevler plant, a vertical tower composed of several horizontal cylinders. At the top, 'Slaked Lime' is added through a hopper. 'Chlorine Gas' is introduced at the bottom. The cylinders are equipped with mixing shafts and blades. The final product, 'Bleaching Powder', is collected at the base of the tower.

Manufacture of Bleaching Powder - BACHMANN'S PLANT

Bachmann's plant consists of vertical towers made of cast iron. The towers are provided with a hopper at the top, two inlets near the base (one for chlorine and other for hot air) and an exit for waste gases near the top.

- The tower is fitted with eight shelves at different heights each equipped with rotating rollers.
- The slaked lime is introduced through the hopper.
- Slaked lime comes in contact with chlorine.
- Bleaching powder is collected in a barrel at the base.

The diagram shows Bachmann's plant, a vertical tower with horizontal shelves. 'Slaked Lime & Compressed Air' enter from the top through a hopper. 'Chlorine Gas' enters from the bottom. The tower has 'Shelves' with 'Rollers'. 'Bleaching Powder' is collected at the base. 'Waste Gases' exit from the top.

E. Charts, Acids, Bases and Salts

F. Charts, Electrolysis

Acids, Bases and Salts

ACIDS

Acids are the substances that are sour in taste, change blue litmus to red and give H⁺ (hydrogen ion) when dissolved in water. Acids have a pH less than 7.



Common acids: HCl, H₂SO₄, HNO₃

Acids are sour-tasting. They react with metals, blue litmus paper.



Acids turn blue litmus red.



Acids react with metals to form hydrogen gas.



Acids are used in many industries, e.g., fertilizers, dyes, pigments, etc.



BASES

Bases are substances that produce hydroxide ions (OH⁻) when dissolved in water. A base is a substance that gives OH⁻ (hydroxide) ions when dissolved in water. Bases have a pH greater than 7.



Common bases: NaOH, KOH, NH₄OH

Bases are bitter-tasting. They react with acids, red litmus paper.



Bases turn red litmus blue.



Bases react with acids to form salts and water.



Bases are used in many industries, e.g., soaps, detergents, etc.



SALTS

Salt is produced because of neutralization.

Salt = metal ion + non-metal ion **Salt = metal ion + metal ion** **Salt = metal ion + non-metal ion**

Salt = metal ion + hydroxide ion **Salt = metal ion + metal ion** **Salt = metal ion + non-metal ion**

Salt = metal ion + hydroxide ion **Salt = metal ion + metal ion** **Salt = metal ion + non-metal ion**

Salt = metal ion + hydroxide ion **Salt = metal ion + metal ion** **Salt = metal ion + non-metal ion**

Salt is produced because of neutralization.



Salt is produced because of neutralization.



Salt is produced because of neutralization.



Electrolysis

Electrolytic effect of the decomposition of a substance (electrolyte) by an electric current

Electrolysis of molten NaCl

Electrolysis of the molten salt. The electrodes are placed in the molten salt. The molten salt is placed in a beaker. The electrodes are connected to a power source. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten NaCl produces sodium metal and chlorine gas.

At cathode:

$$Na^+ + e^- \rightarrow Na$$

At anode:

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

Overall reaction:

$$2NaCl \rightarrow 2Na + Cl_2$$

Electrolysis of aqueous NaCl

Electrolysis of an aqueous solution of NaCl. The electrodes are placed in the aqueous solution. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of aqueous NaCl produces hydrogen gas and sodium hydroxide.

At cathode:

$$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$$

At anode:

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

Overall reaction:

$$2NaCl + 2H_2O \rightarrow H_2 + Cl_2 + 2NaOH$$

Electrolysis of molten Al₂O₃

Electrolysis of molten Al₂O₃. The electrodes are placed in the molten Al₂O₃. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten Al₂O₃ produces aluminum metal and oxygen gas.

At cathode:

$$Al^{3+} + 3e^- \rightarrow Al$$

At anode:

$$2O^{2-} \rightarrow O_2 + 4e^-$$

Overall reaction:

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Electrolysis of molten CuSO₄

Electrolysis of molten CuSO₄. The electrodes are placed in the molten CuSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten CuSO₄ produces copper metal and sulfuric acid.

At cathode:

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

At anode:

$$2SO_4^{2-} \rightarrow 2SO_3 + O_2 + 4e^-$$

Overall reaction:

$$2CuSO_4 \rightarrow 2Cu + 2SO_3 + O_2$$

Electrolysis of molten ZnSO₄

Electrolysis of molten ZnSO₄. The electrodes are placed in the molten ZnSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten ZnSO₄ produces zinc metal and sulfuric acid.

At cathode:

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

At anode:

$$2SO_4^{2-} \rightarrow 2SO_3 + O_2 + 4e^-$$

Overall reaction:

$$2ZnSO_4 \rightarrow 2Zn + 2SO_3 + O_2$$

Electrolysis of molten FeSO₄

Electrolysis of molten FeSO₄. The electrodes are placed in the molten FeSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten FeSO₄ produces iron metal and sulfuric acid.

At cathode:

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

At anode:

$$2SO_4^{2-} \rightarrow 2SO_3 + O_2 + 4e^-$$

Overall reaction:

$$2FeSO_4 \rightarrow 2Fe + 2SO_3 + O_2$$

Electrolysis of molten PbSO₄

Electrolysis of molten PbSO₄. The electrodes are placed in the molten PbSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten PbSO₄ produces lead metal and sulfuric acid.

At cathode:

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

At anode:

$$2SO_4^{2-} \rightarrow 2SO_3 + O_2 + 4e^-$$

Overall reaction:

$$2PbSO_4 \rightarrow 2Pb + 2SO_3 + O_2$$

Electrolysis of molten SnSO₄

Electrolysis of molten SnSO₄. The electrodes are placed in the molten SnSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten SnSO₄ produces tin metal and sulfuric acid.

At cathode:

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

At anode:

$$2SO_4^{2-} \rightarrow 2SO_3 + O_2 + 4e^-$$

Overall reaction:

$$2SnSO_4 \rightarrow 2Sn + 2SO_3 + O_2$$

Electrolysis of molten NiSO₄

Electrolysis of molten NiSO₄. The electrodes are placed in the molten NiSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten NiSO₄ produces nickel metal and sulfuric acid.

At cathode:

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

At anode:

$$2SO_4^{2-} \rightarrow 2SO_3 + O_2 + 4e^-$$

Overall reaction:

$$2NiSO_4 \rightarrow 2Ni + 2SO_3 + O_2$$

Electrolysis of molten CoSO₄

Electrolysis of molten CoSO₄. The electrodes are placed in the molten CoSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten CoSO₄ produces cobalt metal and sulfuric acid.

At cathode:

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

At anode:

$$2SO_4^{2-} \rightarrow 2SO_3 + O_2 + 4e^-$$

Overall reaction:

$$2CoSO_4 \rightarrow 2Co + 2SO_3 + O_2$$

Electrolysis of molten MnSO₄

Electrolysis of molten MnSO₄. The electrodes are placed in the molten MnSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten MnSO₄ produces manganese metal and sulfuric acid.

At cathode:

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

At anode:

$$2SO_4^{2-} \rightarrow 2SO_3 + O_2 + 4e^-$$

Overall reaction:

$$2MnSO_4 \rightarrow 2Mn + 2SO_3 + O_2$$

Electrolysis of molten CrSO₄

Electrolysis of molten CrSO₄. The electrodes are placed in the molten CrSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten CrSO₄ produces chromium metal and sulfuric acid.

At cathode:

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

At anode:

$$2SO_4^{2-} \rightarrow 2SO_3 + O_2 + 4e^-$$

Overall reaction:

$$2CrSO_4 \rightarrow 2Cr + 2SO_3 + O_2$$

Electrolysis of molten VSO₄

Electrolysis of molten VSO₄. The electrodes are placed in the molten VSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten VSO₄ produces vanadium metal and sulfuric acid.

At cathode:

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

At anode:

$$2SO_4^{2-} \rightarrow 2SO_3 + O_2 + 4e^-$$

Overall reaction:

$$2VSO_4 \rightarrow 2V + 2SO_3 + O_2$$

Electrolysis of molten NbSO₄

Electrolysis of molten NbSO₄. The electrodes are placed in the molten NbSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten NbSO₄ produces niobium metal and sulfuric acid.

At cathode:

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

At anode:

$$2SO_4^{2-} \rightarrow 2SO_3 + O_2 + 4e^-$$

Overall reaction:

$$2NbSO_4 \rightarrow 2Nb + 2SO_3 + O_2$$

Electrolysis of molten TaSO₄

Electrolysis of molten TaSO₄. The electrodes are placed in the molten TaSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten TaSO₄ produces tantalum metal and sulfuric acid.

At cathode:

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

At anode:

$$2SO_4^{2-} \rightarrow 2SO_3 + O_2 + 4e^-$$

Overall reaction:

$$2TaSO_4 \rightarrow 2Ta + 2SO_3 + O_2$$

Electrolysis of molten TiSO₄

Electrolysis of molten TiSO₄. The electrodes are placed in the molten TiSO₄. The positive electrode is the anode and the negative electrode is the cathode. The electrolysis of molten TiSO₄ produces titanium metal and sulfuric acid.

G. Charts, Prep. of Chlorine and Hydrochloric Acid

H. Charts, Atoms and Molecules

Prep. of Chlorine and Hydrochloric Acid

Laboratory Preparation of Chlorine

Chlorine is prepared in laboratory by heating manganese dioxide with a mixture of common salt and conc. sulphuric acid.

$$4\text{NaCl} + \text{MnO}_2 + 4\text{H}_2\text{SO}_4 \rightarrow \text{MnCl}_2 + 4\text{NaHSO}_4 + 2\text{H}_2\text{O} + \text{Cl}_2$$

Preparation of Chlorine From Sodium Chloride

Large Scale Manufacture of Chlorine

Chlorine is mostly obtained as a by product during the manufacture of caustic soda, by the electrolysis of brine or molten sodium chloride.

Preparation of Chlorine by Downs Cell

Preparation of Hydrochloric Acid

Glauber prepared hydrogen chloride in 1648 by heating common salt with sulphuric acid. This also served as a laboratory method to prepare HCl.

$$\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$$

$$\text{NaHSO}_4 + \text{NaCl} \rightarrow \text{Na}_2\text{SO}_4 + \text{HCl}$$

Industrially hydrogen chloride gas is made by burning hydrogen in chlorine.

$$\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$$

Hydrogen chloride gas so formed is dissolved in water to form hydrochloric acid.

To dissolve the Hydrogen Chloride gas safely in water a filter funnel is placed in water instead of delivery tube.

Dissolving Hydrogen Chloride Gas in Water

Atoms and Molecules

Atomic number (Z) = Number of protons = Number of electrons (in a neutral atom)

Mass number (A) = Number of protons + Number of neutrons

Isotopes

Atoms having same atomic number but different mass number are called isotopes.

Isotope	Atomic Number (Z)	Mass Number (A)
^1_1H	1	1
^2_1H	1	2

Molecules

Molecules are a group of atoms joined together by chemical bonds.

Molecules of Some Elements

Element	Molecular Formula
Diatomic Molecules	$\text{H}_2, \text{O}_2, \text{N}_2$
Polyatomic Molecules	$\text{CH}_4, \text{CO}_2, \text{H}_2\text{O}$

Molecules of Different Elements

Molecule	Chemical Formula
Water	H_2O
Carbon Dioxide	CO_2

Chemical Formula

Empirical formula is the simplest ratio of atoms in a compound.

Molecular formula is the actual number of atoms in a molecule.

Example: C_6H_6 (Benzene) has empirical formula CH and molecular formula C_6H_6 .

I. Charts, Crystal Lattices

Crystal Lattices

A regular three dimensional arrangement of points in space at which the atoms, molecules or ions of a crystal occur, is a crystal lattice.

Unit cell is the smallest portion of a crystal lattice which, when repeated in different directions, generates the entire lattice.

Unit cell is characterized by:

- Its dimensions along the three edges, a , b and c . These edges may or may not be mutually perpendicular.
- Angles between the edges, α (between b and c), β (between a and c) and γ (between a and b). Thus, a unit cell is characterized by six parameters, a , b , c , α , β and γ .

Crystal System	Relative Unit Cells	Relative Volumes	Examples
Cubic	Simple Cubic, Body-Centered Cubic, Face-Centered Cubic	$a=b=c$, $\alpha=\beta=\gamma=90^\circ$	NaCl, Zinc blende
Tetragonal	Simple Tetragonal, Body-Centered Tetragonal	$a=b \neq c$, $\alpha=\beta=\gamma=90^\circ$	White tin, Sn , TiO_2 , CaTiO_3
Orthorhombic	Simple Orthorhombic, Base-Centered Orthorhombic, Face-Centered Orthorhombic	$a \neq b \neq c$, $\alpha=\beta=\gamma=90^\circ$	Monoclinic sulphur, KNO_3 , BaSO_4
Hexagonal	Simple Hexagonal	$a=b \neq c$, $\alpha=\beta=120^\circ$, $\gamma=90^\circ$	Graphite, Zn , CaF_2
Trigonal	Simple Trigonal	$a=b=c$, $\alpha=\beta=\gamma=120^\circ$	Carbon, SiO_2
Monoclinic	Simple Monoclinic, Base-Centered Monoclinic	$a \neq b \neq c$, $\alpha=\beta=\gamma \neq 90^\circ$	Monoclinic sulphur, $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
Triclinic	Simple Triclinic	$a \neq b \neq c$, $\alpha \neq \beta \neq \gamma \neq 90^\circ$	$\text{K}_2\text{Cr}_2\text{O}_7$, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, H_2SO_4

J. Charts, Solids, Liquids & Gases

Solids, Liquids & Gases

All Matter Occurs in Three Forms - Solid, Liquid and Gas.

The three states of matter differ from one another because of the difference in the attractive and repulsive forces among the constituent particles.

Characteristics of Solids

- Particles have a definite shape. They are closely packed and have very little free space.
- Particles have a definite volume.
- Particles have a definite mass.
- Particles have a definite shape and volume.

Characteristics of Liquids

- Particles have a definite volume but no definite shape. They take the shape of the container they are in.
- Particles have a definite mass.
- Particles have a definite volume and mass.

Characteristics of Gases

- Particles have no definite shape or volume. They fill the entire container they are in.
- Particles have a definite mass.
- Particles have a definite mass and volume.

Change of State

SYMBOLIC STATE	TEMPERATURE	PROCESS	EXAMPLE
Solid to Liquid	Melting	Melting	Ice to Water
Liquid to Solid	Freezing	Freezing	Water to Ice
Liquid to Gas	Boiling	Boiling	Water to Steam
Gas to Liquid	Condensation	Condensation	Steam to Water
Solid to Gas	Sublimation	Sublimation	Dry Ice to Gas
Gas to Solid	Deposition	Deposition	Fog to Ice

K.Charts, Preparation of H2 & CO2 L. Charts, Sodium Chloride Crystal

Preparation of H_2 and CO_2

HYDROGEN

Laboratory Preparation

Laboratory preparation involves reaction

Metal + Acid \rightarrow Salt + Hydrogen

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

Commercial Manufacture

Steam Re-forming of Natural Gas

Methane in natural gas is reacted with steam in a reversible reaction to produce hydrogen.

$$CH_4(g) + H_2O(g) \rightleftharpoons 3H_2(g) + CO(g)$$

CO produced is used to reduce unreacted steam to produce more hydrogen.

$$CO(g) + H_2O(g) \rightleftharpoons H_2(g) + CO_2(g)$$

CO₂ + Natural gas \rightarrow H₂ + Natural gas

CARBON DIOXIDE

Commercial Manufacture

CO_2 is produced as a by-product in a lime kiln where limestone (calcium carbonate) is decomposed to produce lime.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

Laboratory Preparation

In the laboratory it is conveniently prepared by the

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

Sodium Chloride Crystal

Formation of sodium chloride involves transfer of electron from chlorine atom to sodium atom. Chloride anions and Sodium cations thus formed are arranged in a regular lattice occupying all the octahedral holes. Each ion is surrounded by six ions of the other kind. This arrangement is known as cubic close packed (ccp).

The arrangement of the positive and negative ions in a sodium chloride crystal.

Crystal Fracture

Pushing one layer against another in an ionic crystal brings ions of the same charge next to each other. The repulsions force the layers apart.

FCC Arrangement

Each face-centered lattice point gives exactly one half contribution, in addition to the corner lattice points, giving a total of 4 atoms per unit cell ($8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$).

NaCl Statistics

Formula	NaCl
Crystal System	Cubic
Lattice Type	Face-Centered
Space Group	Fm $\bar{3}m$, No. 225
Cell Parameters	$a = b = c = 0.564 \text{ nm}$, $\alpha = \beta = \gamma = 90^\circ$
Atomic Positions	Cl: 4a, 0,0,0 Na: 4b, 0.5, 0.5, 0.5
Density	2.16 g cm^{-3}
Melting Point	801°C
Alternate Names	Halite, rock salt, sea salt, table salt, salt
Neighboring Compounds	MgO, TiO, SiC, LaN, NaI, KCl, RbI, AgI, GaN

Salt Crystals and Dissociation

In water sodium and chlorine ions dissociate from the crystal. The \pm sides of the polar water molecules are attracted to the \pm chloride ions and the \pm sides are attracted to the \pm sodium ions. This breaks up the lattice.

M. Charts, Preparation of Sodium Hydroxide (NaOH)

N. Charts, Preparation of Ammonia & Haber Process

Preparation of Sodium Hydroxide (NaOH)

Preparation of NaOH in Castner Kellner Cell

NaOH is commercially prepared by the electrolysis of sodium chloride in Castner Kellner Cell which has mercury as cathode and carbon as anode. A sodium amalgam is formed which is treated with water to give sodium hydroxide and hydrogen gas.

$$2Na\text{-Amalgam} + 2H_2O \rightarrow 2NaOH + 2H_2 + H_2$$

At cathode:
 $Na^+ + e^- \rightarrow Na\text{-amalgam}$

At anode:
 $Cl^- \rightarrow \frac{1}{2} Cl_2 + e^-$

Preparation of Sodium Carbonate (Ammonia Soda or Solvay Process)

Solvay process produces soda ash (Na_2CO_3) from brine and limestone. Calcium chloride is its major by product.

Principal Reactions:

- $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$
- $2NaHCO_3 + H_2O + CO_2 \rightarrow Na_2CO_3 + 2H_2O$
- $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$
- $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$
- $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$
- $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

Preparation of Ammonia & Haber Process

Natural Occurrence

Ammonia (NH_3) is produced by the natural decomposition of animal and plant matter in nature. It also occurs in the soil in the form of ammonium salts.

Laboratory Preparation of Ammonia

From Ammonium Chloride

Ammonia gas is usually prepared in the laboratory by gently heating ammonium chloride (NH_4Cl) and slaked lime [$Ca(OH)_2$].

$$2NH_4Cl(s) + Ca(OH)_2(s) \xrightarrow{\text{heat}} CaCl_2(s) + 2NH_3(g) + 2H_2O(g)$$

The high solubility of ammonia in water should be kept in mind. The gas is collected by downward displacement of air. The water vapour is removed by passing the gas through calcium chloride.

Manufacture of Ammonia by Haber Process

STEPS IN THE HABER PROCESS

- Hydrogen is obtained from methane and steam.
- Nitrogen is obtained from air.
- The two gases (N_2 & H_2) are mixed in ratio 1:3.
- Mixture is compressed in about 200 bar and heated to high temperature.
- Mixture is then goes to reactor containing beds of hot iron. The iron catalyzes the reaction.
- Mixture of N_2 , H_2 & NH_3 leaves the converter. It is cooled to condense ammonia. The N_2 and H_2 are pumped back to the converter.
- Ammonia is stored as liquid under pressure.

O. Charts, Prep. of Sulphur Dioxide & Sulphuric Acid

P. Charts, Preparation of O₂ and Liquefaction of Air

Prep. of Sulphur Dioxide & Sulphuric Acid

PREP. OF SULPHUR DIOXIDE

IN LABORATORY

SO₂ is readily generated by treating a sulphite with dil. sulphuric acid.

$$\text{SO}_3^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{SO}_2(\text{g})$$

INDUSTRIAL PRODUCTION

Industrially it is produced as a by-product of the roasting of sulphide ores. The gas so produced is dried, liquefied under pressure and stored in steel cylinders.

$$4\text{FeS}_2(\text{s}) + 11\text{O}_2(\text{g}) \rightarrow 2\text{Fe}_2\text{O}_3(\text{s}) + 8\text{SO}_2(\text{g})$$

USES OF SULPHUR DIOXIDE

- Used to bleach wood, silk and wool pulp.
- Used as a food preservative and disinfectant.
- Used in the manufacture of sulphuric acid.
- Liquid SO₂ is used as a solvent to dissolve chemicals.

STEPS IN THE CONTACT PROCESS

Sulphur

- Burned in air to form SO₂.

Sulphur dioxide, SO₂

$$\text{S}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{SO}_2(\text{g})$$

- Mixed with more air.
- Passed over four separate beds of catalyst (V₂O₅) at 450°C.

Sulphur trioxide, SO₃

$$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$$

- Absorption of SO₃ in concentrated sulphuric acid to form oleum.

Thick fuming liquid called oleum (H₂S₂O₇)

$$\text{SO}_3(\text{g}) + \text{H}_2\text{SO}_4(\text{l}) \rightarrow \text{H}_2\text{S}_2\text{O}_7(\text{l})$$

- Mixed carefully with water to get concentrated sulphuric acid, H₂SO₄.

PRODUCTION OF SULPHURIC ACID

The steam from a cooling coil melts the sulphur, which is then pumped into a furnace.

In the converter, more oxygen is added to the sulphur dioxide to produce sulphur trioxide.

Sulphur trioxide passed through a spray of sulphuric acid which absorbs the sulphur trioxide. This forms a concentrated fuming liquid called oleum.

The oleum is diluted with water to make sulphuric acid of the right strength.

USES OF SULPHURIC ACID

- Manufacture of Fertilisers
- Metallurgical Applications
- Tanning Leather
- Paints and Pigments

Preparation of O₂ and Liquefaction of Air

Laboratory Preparation of Oxygen

BY HEATING COMPOUNDS CONTAINING OXYGEN

Potassium Chlorate, Manganese Dioxide, Water, Oxygen

Oxygen is usually collected over water because the solubility of the gas in water is very low.

$$2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$$

BY ELECTROLYSIS OF WATER

Hydrogen, Oxygen, Cathode, Anode, Battery

Electrolysis of water is carried out in Hoffman Voltmeter. Oxygen is evolved at anode in the electrolyte.

$$2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$$

Manufacture of Oxygen by Liquefaction of Air

The air is distilled into fractions in this tower, which is cooled by liquid nitrogen.

Distillation Column, Nitrogen (with a little butane, propane and neon), Argon (with some nitrogen and oxygen), Oxygen (with a little nitrogen and neon), Liquid air, Expansion engine, Generator, Recycled air, Cooling of hot compressed gases, Evaporation of air at the engine, Purification of air, Air, Feed tanks, Water.

MAJOR STEPS IN THE PROCESS

- Air is filtered to remove dust.
- Moisture & CO₂ are removed.
- Air is compressed at about 200 atmospheres.
- Compressed air is cooled & passed into cold storage in a chamber.
- Compressed air is allowed to expand in the chamber cooling the coils.
- Expanded gas is returned to the compressor with multiple cooling and expansion and compression steps resulting finally in liquefaction of the compressed air at a temperature of -196°C.
- Liquid air is allowed to warm to distil first the lightest gases, then the nitrogen, leaving liquid oxygen.
- Multiple fractionations will produce 99.5 percent pure oxygen.

Disclaimer

The Products details given on this page are indicative in nature and JAPSON reserves the right to change them without prior notice. Buyer is also requested to re-check the specifications and other features of product at the time of order as product development is a continuous process and minor modifications may be made to design based on latest availability, process and design.