20

MAIN GROUP ELEMENTS AND THEIR COMPOUNDS-I

20.1 INTRODUCTION

The physical and chemical properties of each of the known elements were studied thoroughly and efforts were made to arrange all the known elements in a systematic way in a tabular from. The tabular form of the arrangement of elements is popularly known as Periodic Table. You have studied about it in an earlier lesson. All the elements in groups 1, 2, 13, 14, 15, 16, 17 and 18 are collectively termed as Main Group Elements, these elements and their compounds play a vital role in our daily life.

We shall study the chemistry of main group elements this lesson and the next lesson (Lesson 20 and 21)

20.2 OBJECTIVES

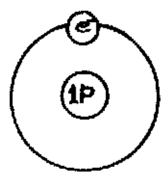
After reading this lesson you will be able to:

- differentiate between the isotopes of hydrogen
- describe the various methods of large scale production of hydrogen.
- define heavy water.
- describe the method of separating heavy water from water.
- appreciate the role of heavy water in nuclear reactors.

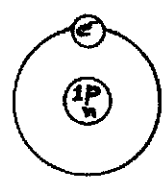
- differentiate between the ortho and the para forms of hydrogen.
- explain the variation in the properties of alkali and alkaline earth metals in terms of their valence electrons and their size.
- describe the methods of preparation and uses of sodium hydroxide, sodium bicarbonate, sodium carbonate, calcium hydroxide, calcuium oxide, calcium carbonate, calcium sulphate, plaster of paris and bleaching powder.
- explain the difference in the properties of compounds of Boron and Aluminium in terms of size of the atoms and non-availablity of d-orbitals,
- explain the structure and Lewis character of halides of Boron and Aluminium.
- Write the structure of Borax and boric acid.
- explain the difference in the properties of compounds of carbon and silicon.
- explain the structure of carbon monoxide, carbon dioxide and silicon dioxide.
- list the properties of carbon monoxide, carbon dioide and silicon dioxide.
- give reasons for the difference in the properties of chlorides of carbon and silicon.
- write the structure of two silicones.
- list the uses of silicones.
- explain the structure of zeolites.
- list the uses of zeolites.
- explain fullerenes.

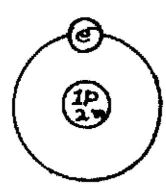
20.3 ISOTOPES OF HYDROGEN

The hydrogen atom consists of a nucleus containing one proton, and one electron revoloing in 1s orbital. This simple variety of hydrogen is symbolized as $^{1}_{1}H$ ($^{\text{mass no}}_{\text{atomic no}}H$) and is also called protium. Naturally occuring hydrogen is composed of three varities of hydrogen; protium deuterium and tritium. The difference in these varities lies in the nucleus containing none, one or two neutrons alongwith a proton. Protium, deuterium and tritium are symbolised as $^{1}_{1}H$, $^{2}_{1}H$, and $^{3}_{1}H$, respectively and are known as the isotopes of hydrogen.



Protium


Deuterium


Tritium

Atoms of the same element (i.e having the same atomic number) that differ in mass number are called isotopes.

Due to differences in masses of different isotopes there arises difference in their properties. This is termed as isotope effect. Since the percentage difference in the masses of isotopes of hydrogen is very large, the difference in properties of isotopes or their compounds containing these isotopes is also quite large.

20.4 LARGE SCALE PRODUCTION OF HYDROGEN

Hydrogen can be prepared by many methods. Some of the methods are discussed below:

1. Where ever electricity is cheap **electrolysis of water** is the method adopted for the large scale production of hydrogen gas. Hydrogen gas of very high purity (99.9%) is produced by electrolysis of acidiluted water. The electrolysis of solutions of NaOH of KOH is done by using a nickel anode and iron cathode. The gases produced at anode and cathode compartments must be kept separate. This particular process is quite expensive. The electrode reactions are as follows :

   At Anode : $2OH^- \longrightarrow H_2O + \frac{1}{2} O_2 + 2e^-$.

   At Cathode : $2H_2O + 2e^- \longrightarrow 2OH^- + H_2$

   Overall : $H_2O \longrightarrow H_2 + \frac{1}{2} O_2$

2. Large scale production of hydrogen gas is done by the steam reformer process. Hydrocarbons of lower molecular mass are mixed with steam and allowed to pass over nickel catalyst at 1073 K to 1173 K. The hydrocarbons present in natural gas are treated as follwos :

$$CH_4 + H_2O \longrightarrow CO + 3H_2$$

$$CH_4 + 2H_2O \longrightarrow CO_2 + 4H_2$$

   The gaseous mixture is cooled to 673 K and passed into a shift converter which contains a Cu-Fe catalyst and converts carbon monoxide to carbon dioxide.

$$CO + H_2O \longrightarrow CO_2 + H_2$$

   Carbon dioxide is absorbed in potassium carbonate solution and can be regenerated by heating.

3. **Laboratory method** of preparation includes :

   a) reaction of zinc and dil acid.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

   b) reaction of lithium hydride with water

$$LiH + H_2O \longrightarrow Li(OH) + H_2$$

20.5 HEAVY WATER AND ITS APPLICATIONS

Water containing Deuterium in place of ordinary hydrogen (Protium) is termed as heavy water.

Heavy water (D_2O) is separated from water by elctrolysis. The dissociation of water containing protium is very high as compared to water containing deuterium e.g. :

$$H_2O \longrightarrow H^+ + OH^-$$

$$D_2O \longrightarrow D^+ + OD^-$$

If we start electrolysing water, water contaning protium gets ionised very fast where as the remaining water becomes enriched with D_2O. In order to obtain one litre of almost pure D_2O, we have to electrolyse about 30,000 litres of ordinary water. Heavy water is used as a moderator in nuclear reactors. In this process, the high speed neutrons are passed through heavy water in order to sl ow down their speed.

20.6 ORTHO AND PARA HYDROGEN

As you know a molecule of hydrogen is composed of two atoms of hydrogen. The nucleur spin of the hydrogen atoms may be clockwise or anti-clockwise. In a particular molecule the two nuclei may be spinning in the same direction or opposite directions.

Parallel spins ortho hydrogen — anti parallel spins para hydrogen

If the spins of the two nuclei of hydrogens in a molecule are parallel, the molecule of hydrogen is said to be orthohydrogen. On the other hand if the spins of the two nuclei of hydrogen are anti parallel the moleule of hydrogen is para hydrogen. Ortho hydrogen and para the hydrogen are said to be spin isomers.

20.7 ALKALI AND ALKALINE EARTH METALS

Alkali metals are placed in group 1 of the periodic table. They readily form unipositive ions. As we go down the group, the alkali metals show steady increase in size due to the addition of new shell at each step. The increase in size of atom or its ion, directly influences the physical and chemical properties of the alkali metals. some physical properties are tabulated in Table 20.1

Table 20.1: Physical properties of alkali metals.

SYMBOL	IONIC RADIUS (A)	FIRST IONIZATION ENERGY	ELECTRO NEGATIVITY	DENEITY (g/cm^3)	M.P. (K)
Li	0.76	520.1	1.0	0.54	454
Na	1.02	495.7	0.9	0.97	371
K	1.38	418.6	0.8	0.86	336
Rb	1.52	402.9	0.8	1.53	312
Cs	1.67	375.6	0.7	1.90	301.5

The alkali metals are soft, highly reactive and very good conductors of electricity. The single electron in the outermost orbit of each atom is loosely bound to the nucleus. The looseness becomes more pronounced as we go down the group.

The looseness is inversely proportional to the ionization energy of any of these elements and dictates the reactivity of that element. The ionization energy is directly proportional to electronegativity. Thus we see an increases in metallic character as we go down the group. The reactivity of the metal also shows steady increase down the group. You can observe this trend in table 20.1

INTEXT QUESTIONS : 20.1

1. What is the atomic mass of tritium.

   ....

2. Name three isotopes of hydrogen.

   ....

3. List the Alkali metals in the order of their decreasing reactivity.

   ....

4. State the relationship between reactivity and size of an alkali metal.

   ....

20.8 ALKALINE EARTH METALS

You have seen a gradual increase in the size of the alkali metals as we move down in the group 1 of the Periodic Table. Identical observation may be made in case of alkaline earth metals placed in Group-2 of Periodic Table (see periodic table). Some physical properties of the alkaline earth metals is given in table 20.2

Table 20.2: Table showing the gradual change in properties.

SYMBOL	METALLIC RADIUS (A)	FIRST IONI-ZATION ENERGY (kJ mol^{-1})	ELECTRO NEGATIVITY	DENSITY (g/cm^3)	m.p. (K)
Be	1.12	899	1.5	1.85	454
Mg	1.60	737	1.2	1.74	371
Ca	1.97	590	1.0	1.55	336
Sr	2.15	549	1.0	2.63	312
Ba	2.22	503	0.9	3.62	301.5

An alkaline earth metal is smaller in size that its adjecent alkali metal. This is due to the added proton in the nucleus which exerts pull on the electrons in an atom resulting in squeezing of the atom. This reduction in size. Shows higher control of the nucleus on the electrons in the shells.

The properties of the elements in Group 2 show a regular gradation. Consider a case where there are 12 protons in the nucleus in addition to neutrons, and 12 electrons are revolving around the nucleus. The electronic configuration being $1s^2\ 2s^2\ 2p^6\ 3s^2$. The two electrons in 3s sub-shell are farthest from the hold of the nucleus and can thus be removed by the applications of energy. When one electron is removed, the eleven electrons and 12 proton system (Mg^+) contracts further due to higher number of positive charges in the nucleus (Mg^+ is indeed smaller in size than Mg atom). More application of energy on the eleventh electron, results in the production of a dispositive charged ion, Mg^{++}, which is likely to be quite stable due to the inert gas configuration possessed by it.

The ease of loosing electrons makes the alkaline earth metals good reducing agent. But this property is less prominent as compared with the corresponding alkali metals. Beryllium being smalll in size does not favour loss of electrons easily and thus shows a deviation in this property.

20.9 OXIDES OF ALKALI METALS

All members of the alkali metals form oxides which are basic in nature. Lithium forms only one type of oxide. Lithium monoxide (Li_2O). Sodium forms the monoxide Na_2O and the per oxide Na_2O_2. Sodium peroxide is formed when sodium is heated with oxygen. Other metals of this group form super oxides when reacted with oxygen.

$$4Na(s) + O_2\ (g) \longrightarrow 2Na_2O(s)$$
$$2Na(s) + O_2\ (g) \longrightarrow Na_2O_2(s)$$
$$2K(s) + O_2\ (g) \longrightarrow K_2O_2(s)$$

The formation of a particular oxide is determined by the size of the metal ion. Lithium by virtue of its small size is not able to come in contact with in sufficient number of per oxo ions (–O–O–). However, the ions of potassium, rubidium and caesium are large enough to come in close contact with per oxo ion and form stable structures as super oxides.

20.10 COMPOUNDS OF ALKALI METALS

Alkali metals form several important compounds which have wide application in different fields. You shall learn the methods of preparation and uses of some of the compounds of alkali metals.

(i) **Sodium hydroxide or caustic soda (NaOH)**

Preparation:

a) **By causticising process:** A dilute solution of sodium carbonate when reacted with hot milk of lime, gives NaOH.

$$Na_2CO_3 + Ca(OH)_2 \longrightarrow CaCO_3 + 2NaOH$$

b) **Electrolytic process:** By the electrolysis of sodium chloride (brine) solution.

$$NaCl\ (aq) \longrightarrow Na^+\ Cl^-\ (aq)$$

At Cathode : $Na^+ + e^- \longrightarrow Na$

At Anode : $2Cl^- \longrightarrow Cl_2 + 2e^-$

Overall Reaction : $2\ Na + 2\ H_2O \longrightarrow 2NaOH + H_2$

Ueses

It is used in the manufacture of soap, paper and artificial silk. It is used in petrolium refining and for purification of bauxite. It is a good cleaning agent.

ii) **Sodium bicarbonate or Baking Soda ($NaH\ CO_3$)**

Preparation :

It is prepared by the action of sodium carbonate and carbondioxide.

$$Na_2CO_3\ (aq) + CO_2(g) + H_2O\ (l) \longrightarrow 2NaHCO_3\ (eq)$$

Uses:

It is used as baking power, as a mild antiseptic and in fire extinguishers

iii) **Sodium Carbonate or Washing Soda ($Na_2\ CO_3$) or Soda Ash:**

Preparation :

It is prepared by Solvay process or Ammonia Soda process The chemical reactions involved in various steps in its manufacture are as follows :

i) $2NH_3 + H_2O + CO_2 \longrightarrow (NH_4)_2CO_3$

ii) $(NH_4)_2CO_3 + CO_2 + H_2O \longrightarrow 2NH_4HCO_3$

iii) $NH_4HCO_3 + NaCl \longrightarrow NaHCO_3 + NH_4Cl$

iv) After filtration, $NaHCO_3$ is heated strongly to get Na_2CO_3

$$2NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + H_2O$$

v) Ammonia and carbondioxide being costly are recovered.

Uses :

It is used for softening hard water and as a reagent in the laboratory. It is used in the preparation of water glass, borax, NaOH etc.

20.11 COMPOUNDS OF ALKALINE EARTH METALS

In this section you shall learn about the methods of preparation and uses of some of the compounds of alkaline earth metals.

i) Calcium hydroxide or slaked lime [Ca(OH$_2$]

Preparation :

It is prepared by the action of water on quick lime

$$CaO\ (s) + H_2O\ (l) \longrightarrow Ca(OH)_2\ (s)$$

Uses:

It is used as a base and as medicine.

ii) Calcium oxide or quick lime (CaO) :

Preparation:

It is prepared by heating lime stone.

$$CaCO_3 \xrightarrow{1273\ K} CaO + CO_2$$

Uses :

It is used in manufacture of bleaching powder and glass. It is also used in tanning industry and for purification sugar. CaO is used in cement industry.

iii) Calcium Carbonate ($CaCO_3$) or Lime Stone

Preparation :

i) Carbondioxide is passed through lime, and Calcium Carbonate is precipitated out.

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$$

Uses :

Calcium carbonate is used in the preparation of quick lime (CaO), talcum powder, tooth pastes and washing soda.

(iv) Calcium sulphate ($CaSO_4$)

Preparation :

i) By the action of $CaCO_3$ and H_2SO_4.

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + CO_2$$

ii) By the action of $CaCl_2$ and Na_2SO_4.

$$CaCl_2 + Na_2SO_4 \longrightarrow CaSO_4 + 2NaCl$$

Uses:

it is uesd in manufacturing plaster of paris.

v) **Plaster of paris ($CaSO_4 \frac{1}{2} H_2O$)**

Preparation :

It is prepared by heating gypsum between 393 to 403 K.

$$2CaSO_4 . 2H_2O \longrightarrow 2(CaSO_4 . \frac{1}{2} H_2O) + 3H_2O$$

Uses :

It is used in making casts for statues. It is also used for plastering fractured bones of the body for preparation of black board chalks.

vi) . **Bleaching Powder ($CaOCl_2$)**

Preparation :

Bleaching powder is prepared by passing chlorine through lime water

$$Ca(OH)_2 + Cl_2 \longrightarrow Ca\ OCl_2 + H_2O$$

Ueses :

It is used for the preparation of elementary chlorine. It is used as a strong bleaching agent.

20.12 BORON AND ALUMINIUM

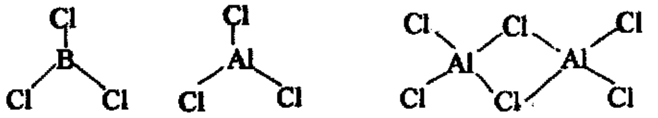
The elements placed in group 13 of the periodic table show gradation in properties, (see periodic table) Each member of the group posses valence shell electronic configuration ns^2 np^1 The trends in properties within the group are not as regular as we had observed among alkali metals and alkaline earth metals.

The metallic character steadily increases down the group. Boron being predominantly non-metallic, forms co-valent compounds. The electronic configuration of boron and aluminium are $1s^2\ 2s^2\ 2p^1$ and $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$ respectively. Though the electronic configuration of boron and aluminium seems to be similar but there is a big difference between the properties of their compounds. This will become clear when we examine the structures of some of the compounds of Boron and Aluminium in detail.

20.13 HALIDES OF BORON AND ALUMINIUM

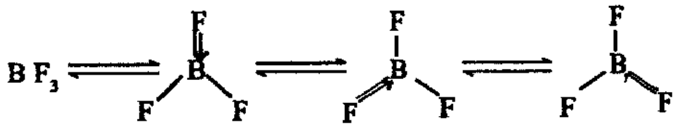
The origin of 'd' orbitals in Aluminium changes the chemical behaviour of aluminium in combined state. Let us consider the case of halides of Boron and Aluminium. Boron trichloride and aluminium trichloride are famous for the bonding they contain and for the shapes of their molecules. In, the figure you can see the shapes of the isolated molecules and of the dimer that aluminium trichloride makes.

The shapes of BCl_3, $AlCl_3$ and the dimer Al_2Cl_6



BCl_3 and $AlCl_3$ possess electron deficient structure (Aluminum chloride is commonly found as Al_2Cl_6 a dimer). The central boron atom in BCl_3 and Al atom in $AlCl_3$ contain only six electrons, i.e still short of 2 electrons to complete the octet. These compounds thus show reactivity towards donor molecules (Lewis base) and thus act as strong Lewis acids.

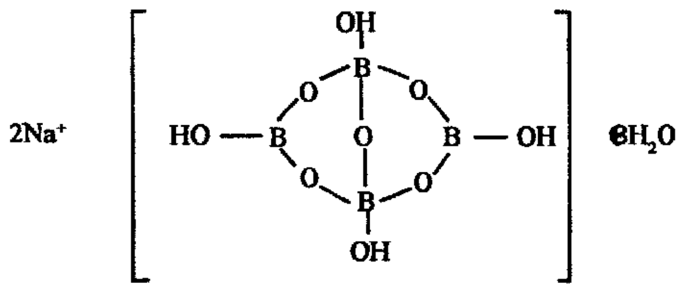
The structure of another halide of boron. BF_3 is given below:



Boron Triflouride

20.14 BORAX

When Boron atom is bonded to three oxygen atoms, a simple borate structure is developed. Borax is the most common metaborate. It is normally written as $Na_2B_4O_7\,10H_2O$. However it can better be represented as $Na_2B_4O_5(OH)_4\,8H_2O$. The structure of borax is shown in figure

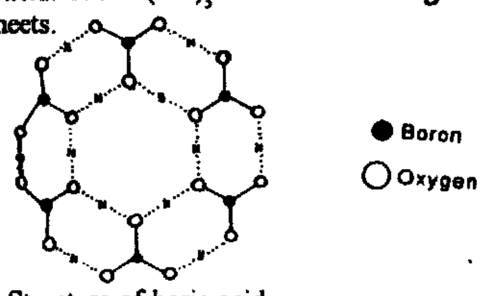


Structure of Borax

This structure is made up of two triangular and two tetrahedral units.

20.15 BORIC ACID

Boron has a great affinity for oxygen. Boron atom gets linked with oxygen to form B_2O_3 which can be used to form boric acid. The $B(OH)_3$ units are linked together by hydrogen bonds to give two dimensional sheets.



Structure of boric acid

Hydrogen bonds linking the oxygen of different $B(OH)_3$ groups are not symmetrical in reference to oxygen around them. The two dimensional sheets are held together by weak van der waal's forces. The weak forces are responsible for the cleavage of the solid structure into flakes.

INTEXT QUESTIONS : 20.2

1. Write the formula of the follwoing :-
   (i) Borax
   (ii) Boric acid

   ....

2 Identify the localtion of Li, Mg, Be, Al, B and Si in the periodic table.

   ....

3. Write two uses of each of baking soda and soda ash.

   ....

20.16 CARBON AND SILICON

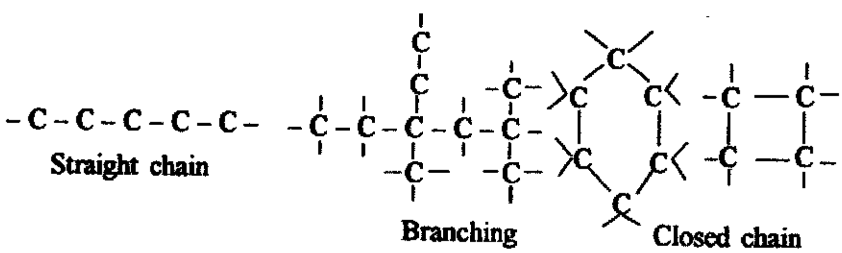
Carbon and silicon belong to Group 14 of the periodic table. Both elements show significant differences in their chemistry. There are thousands of hydrocarbons (alkanes and other compounds of carbon and hydrogen) but only a few silanes are known. Let us have a look at the electronic configuration of carbon and silicon.

The normal valency of carbon and silicon is four, but apart from carbon, silicon can make more than four bonds. This is because silicon can make use of a set of d-orbitals in bonding. These are the empty 3d orbitals of the outer most shell. The avilablility of d-orbitals is responsible for the ability of silicon (and not carbon) to make complex ions such as SiF_6. This is a very important difference betweeen carbon and silicon.

Another difference between carbon and silicon is the difference in their reactivity, which is due to difference in the strength of C-C and Si-Si bonds. The C-C bond is the strongest bond among all single covalent bonds between like atoms.

Carbon also differs from all other members of the group in its unique ability to form multiple bonds such as C = O, C=S, C=C, C≡C, and C≡N.

In addition carbon is also found to differ markedly in its ability to bond in a variety of ways resulting in the formation of straight chain, branches, closed chains etc. This ability is termed as Catenation.



Varieties of carbon bonds (Catenation)

20.17 OXIDES OF CARBON AND SILICON

Structure

Carbon froms two oxides i.e., carbon monoxide and carbon dioxide. The bonding in carbon monoxide may be represented as three electron pairs shared between the two atoms.

$$:C:::O: \quad \text{or} \quad :C \equiv O:$$

The structure of carbon dioxide on the other hand is linear O=C=O and the carbon atoms uses sp^2 hybrid orbitals. (refer to lesson on chemical bonding). There are two π bonds in addition to two σ bonds in CO_2.

$$O = C = O$$

Silicon also forms two oxides : SiO and SiO_2. Not much is known about the silicon monoxide as its existence is only known at high temperature. Silicon dioxide is commonly known as sillica and is widely found as sand and quartz.

SiO_2 is a high melting solid and it exists in twelve different forms. The main form being quartz and cristobalite each of which has different structure at different temperatures. In all these forms silicon is tetrahedrally surrounded by four oxygen atoms. Each corner of tetrahedron is shared by the other tetrahedron. This gives an infinite structure—a macromolecule. Silica is unreactive in all its forms. However, with HF it forms SiF_4.

Properties

Carbon Monoxide is a colourless odourless poisonous gas and it burns with a blue flame. It is toxic because it forms a complex carboxy—haemoglobin with the heaemoglobin in the blood which prevents the haemoglobin in the blood corpuscles from carrying oxygen around the body. This leads to oxygen deficiency leading to unconsiousness or death. carbon monoxide is an important industrial fuel and is also a strong reducing agent.

Carbon dioxide is a colourless odourless gas and can be liquified under pressure at low temperatures. Solid carbon-dioxide is called dry-ice.

SiO_2 is an acidic oxide and shows very limited reactions. It dissolves slowly in aqueous alkalies and more rapidly in fused alkalies or fused carbonates forming silicates. Silica also reacts with flourine:

$$SiO_2 + 2F_2 \longrightarrow SiF_4 + O_2$$

20.18 HALIDES OF CARBON AND SILICON

Carbon and silicon from tetra halides like CCl_4. and $SiCl_4$ repectively silicon too forms a complex ion like SiF_6^{2-}

There is a tendency of these elements to make four bonds, with a tetrahedral arrangement there is a marked difference in the hydrolysis reactions of tetrachloromethane and silicon tetrachloide. CCl_4 will not react with water, but $SiCl_4$ is inmediately converted into silica:

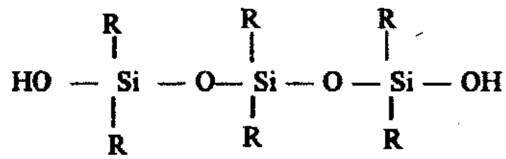
$$SiCl_3 + 2H_2O \longrightarrow SiO_2 + 4H^+ + 4Cl^-$$

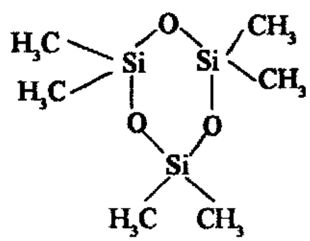
We can explain this difference by assuming that one of the lone pairs on a water molecule can overlap with one of the empty 3d orbitals on the silicon atom. The 3d orbitals of silicon are only slightly higher in energy then is 3s and 3p orbitals bonding can occur between them and their molecule.

20.19 SILICONES

Silicones are a group of polymers containing Si-O-Si units. These compounds have the general formula (R_2SiO) where R is an alkyl or aryl group. They are chain, cyclic and ion-linked polymers.

Two types of structures of silicones is given below:

(i)  ($R = CH_3$)

(ii) 

Uses :

Silicones are widely used as sealants and greases where their water repellent properties are extremely useful. It may be possible that a burette you use may have its tap lubricated with silicone grease. Their ability to repel water also makes them a suitable material for treating fabrics to be used in rain coats others are used in waxes and polishes. Some silicones exist as crosslinked polymers. They can be hard. They find use in insulating electrical equipment some special adhesives are made by mixing two silicon based material, which react together when mixed, to give a crosslinked polymer.

20.20 ZEOLITES

Zeolites are cage like structures made from silicates. They have emply spaces in their sturctures into which ions can fit. An example of zeolite is $Na_{12}(Al_{12}Si_{12}O_{48})\ 27H_2O$. The structure of this zeolite is based on a combination of cubes and octahedral there is a large hole in the centre, and smaller ones inside the other frameworks, in which atoms molecules or ions can be trapped.

Zeolites have comparatively more open structures amongst these dimensional silicate structures. They are capable of absorbing or loosing water or other molecules of similar size. It is due to this reason that the zeolites are used as ion exchange materials and moleculor sieves for purification of water. Natrolite is one such material used as an ion exchanger.

Zeolites in the form of molecular sieves can separate, carbon dioxide, ammonia and ethanol from water by absorbing small molecules in its cavaties. Some straight chain hydrocarbons can also be separated from branched chain hydrocarbons with the help of these molecular sleves.Zeolites can be regenerated after using.

20.21 FULLERENES

Fullerene is a newly discovered allotrope of carbon. The newly discovered from of carbon, fullerenes, is named as "Buckminster Fullerene" after the name of the American architect Buckminster Fuller. Fullerene has a definite structure of C60. Other fullerenes having C70, C76 C90 sturcture, are also known. The 60 carbon atoms are linked in such a way that they form 12 pentagons and 20 hexagons so as to create a hollow ball where metal ions can find a place. Even the outer surface of fullerenes can be altered by chemical reactions.

INTEXT QUESTIONS : 20.3

1. Draw the structure of SiO_2.

    ....

2. State two uses of each of the following :

    a) Silicones

    b) Zeolites

    ....

3) Which of the following statements are true.

    i) Silicones are two dimensional sheets.

    ii) Zeolites are an extremely costly material as compared to silicones

    iii) Sodium zeolite is a water softner.

    iv) Zeolites in the form of molecular sieves can separate ammonia from water.

    v) Silicones are resistant to heat.

    ....

20.22 WHAT YOU HAVE LEARNT

- Hydorgen exists in three isotopic forms namely hydrogen, deuterium and tritium.
- Hydrogen can be prepared large scale by electrolysis method and steam reformer process. It can also be prepared in the laboratory.
- Water containing deuterium in place of ordinary hydrogren (Protium) is known as heavy water.
- Heavy water can be separated from ordinary water by electrolysis.

- Heavy water is used as moderator in nuclear reactors.
- If the spins of the two nuclei in a molecule of hydrogen are parallel, the molecule is said to be ortho hydrogen; if the spins of the two hydrogen nucle are anti parallel, the molecule is para hydrogen.
- The alkali and alkaline earth metals show regular variation in various properties along a group and a period.
- Sodium hydroxide is prepared by causticising process and electrolysis process. It is used in the manufacture of soap, paper, artificial silk etc.
- Sodium bicarbonate is used as bakinbg powder, as a mild antiseptic and in fire extinguishers.
- Sodium carbonate is prepared by solvay process. It is used for softening hard water, for preparing water glass, borax etc.
- Calcium hydroxide is used as a base and as medicine.
- Calcium oxide is prepared by heating lime stone and is used in manufacture of bleaching powder and glass.
- Calcium carbonate is used in the preparation of talcum powder, tooth paste and washing soda.
- Calcium sulphate is used in manufacturing plaster of paris.
- Plaster of paris is prepared by heating gypsum and is used in making casts for statues and for plastering fractured bones of the body.
- Bleaching powder is used in preparing elementary chlorine and as a strong bleaching agent.
- Boron and Aluminium act as a Lewis acid
- Carbon and silicon differ in their properties due to availability of d-orbitals in silicon.
- Carbon forms two oxides, carbon monoxide and carbon dioxide.
- Silicones are a group of polymers containing Si-O-Si units.
- Zeolites have a three dimensional silicate structure and are used as molecular sieves
- Fullerene is a newly discovered allotrop of carbon.

20.23 TERMINAL EXERCISE

1. Name the isotope of hydrogen, that is heavier than Deuterium.
2. Write one method used for the large scale production of hydrogen.
3. Write the general electronic configuration of the valences shell of alkai metals.
4. State two uses of caustic soda.

5. Write one reaction each for the preparation of the following :
   i) Bleaching powder
   ii) caustic soda
   iii) Baking powder
   iv) Soda ash

CHECK YOUR ANSWERS

INTEXT QUESTIONS 20.1

1. 3
2. Protium, deuterium, tritiun
3. Cs, Rb, K, Na, and Li
4. The bigger the size of an alkali metal, the more reactive it will be.

INTEXT QUESTIONS 20.2

1. (i) $Na_2B_4O_7 \cdot 10H_2O$
   (ii) H_3BO_3
2. See Text
3. See Text

INTEXT QUESTIONS 20.3

1. See text
2. for making silica gel
   for making electronic chips
   for making silicon grease
3. a) elastomer and resin
   b) water softener, as molecular sieve
   c) as cutting materrial and as grating
4. (iii) and (v)

TERMINAL EXERCISE

1. Tritium
2. See Text
3. $n\,s^2$
4. See Text
5. See Text.