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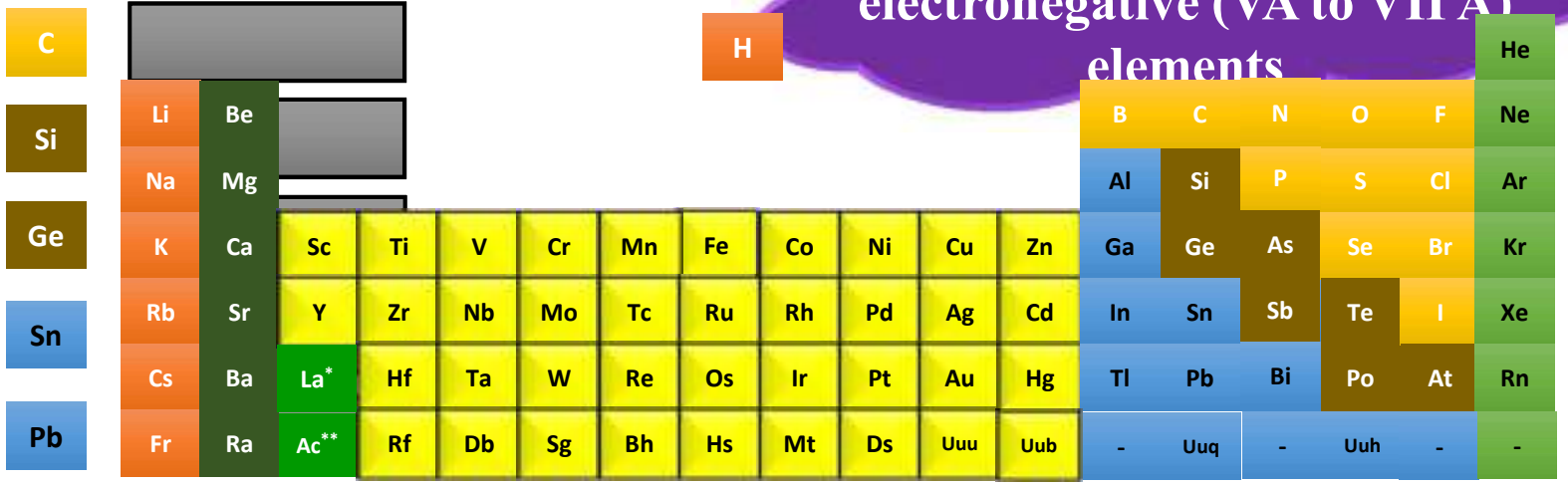
An Initiative by अमर उजाला

GROUP 14 ELEMENTS

INTRODUCTION
&
PROPERTIES
OF IVA GROUP ELEMENTS

GROUP 14th ELEMENTS

They form a link between electropositive (IA to III A) and electronegative (VA to VII A) elements



* Lanthanoids	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
** Actinoids	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Properties of IVA group elements

1) Electronic configuration

General electronic configuration is $ns^2\ np^2$

$_{6}C = 1s^2\ 2s^2\ 2p^2$

$_{14}Si = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$

$_{32}Ge = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 3d^{10}\ 4p^2\ 4p^2$

Properties of IVA group elements

1) Electronic configuration

General electronic configuration is $ns^2\ np^2$

$_{50}Sn = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2\ 5p^2$

$_{82}Pb = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^2\ 6p^2$

GROUP 13 ELEMENTS

Abundance :

Abundance of these elements in earth crust is Si > C > Sn > Pb > Ge

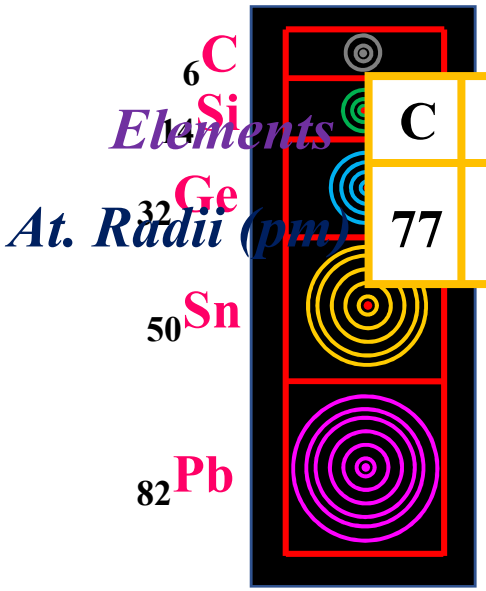
Occurrence :

- **Carbon exists in elemental state & also in combined state**
- **Silicon exists as silica and silicates**
- **Tin exists as cassiterite (or) Tinstone SnO_2**
- **Lead exists as Galena PbS ,cerussite $PbCO_3$**

Properties of IVA group elements

2) Atomic or ionic radius

Down the group atomic size increases with increase in atomic number due to the addition of new shells

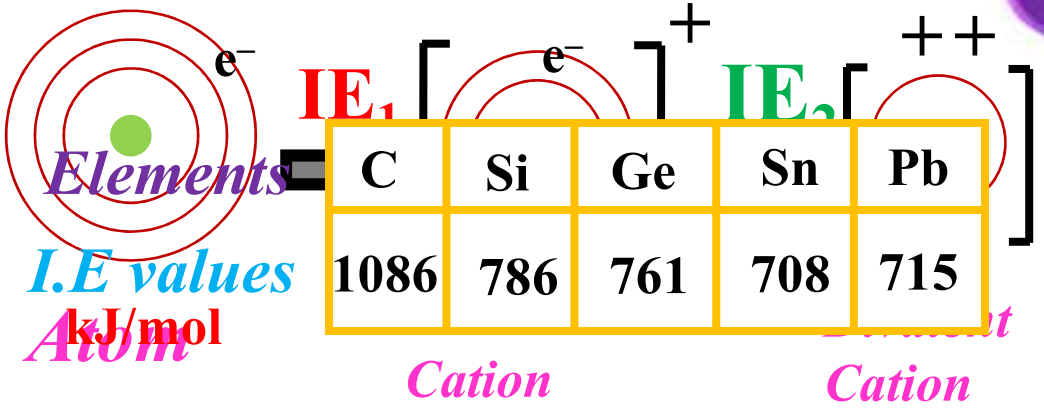


Elements	C	Si	Ge	Sn	Pb
At. Radii (pm)	77	118	122	140	146

Properties of IVA group elements

3) Ionization enthalpy

I.E. decreases with increase in atomic radii because electrons become more loosely held due to shielding by inner electrons of the inner shells.



C	Si	Ge	Sn	Pb
1086	786	761	708	715

Ionization enthalpy decreases from C to Sn and marginally increases for Pb.

∴ 'C' has highest IE in IVA group

1st I.P. order C > Si > Ge > Pb > Sn

Properties of IVA group elements

4) Electro negativity

What is electro negativity?

The tendency of an atom to attract the shared pair of electrons towards itself.

- **Electro negativity decreases from C to Si but from Si to Sn remains almost constant and marginally increases for Pb.**

Elements	C	Si	Ge	Sn	Pb
E.N values	2.5	1.8	1.8	1.8	1.9

- **Therefore, carbon is the most electro negative element among IVA or group 14th elements.**

Properties of IVA group elements

5) Physical properties

- All group IVA elements are solids.
- C & Si = non-metals, Ge & Sn = metalloids and Pb = soft Metal.
- Down the group there is a regular decrease in melting & boiling points but densities increase.
- M.P :- C > Si > Ge > Pb > Sn
- B.P :- C > Ge > Sn > Si > Pb

Density : - C Si (dec) Ge Sn Pb (inc) i.e, Pb > Sn > Ge > C > Si

Properties of IVA group elements

5) Physical properties

- **Group IVA elements have higher melting & boiling points than group IIIA elements due to increase in nuclear charge and more compactness.**

MCQs

1. Well known Radio active isotope of carbon is...

a) C^{12}

b) C^{13}

c) C^{14}

d) C^{11}

2. Which of the IVA group element shows highest density?

a) C

b) Si

c) Sn

d) Pb

3. The number of valency electrons in carbon atom…

a) 2

b) 3

c) 4

d) 6

4. Which of the following element is a soft metal with lower melting point.?

a) C

b) Si

c) Ge

d) Pb

5) If electronegativity of ‘Si’ is 1.8 then electronegativity of ‘Ge’ is

a) 1.7

b) 1.9

✓ 1.8

d) 1.6

CHEMICAL PROPERTIES OF IVA GROUP ELEMENTS (PART-I)

Chemical Properties IVA group elem

Oxidation state and trends in chemi

The tendency of the outer s-electrons to remain paired & not take part in bonding down the group because of poor shielding effect.

- Their common oxidation states are
- Their valence shells contain 4 electrons so the maximum possible oxidation state is +4 .
- Lower members in the group shows +2 oxidation state more than +4 oxidation state due to *inert pair effect.*

Chemical Properties IVA group elements

Oxidation state and treads in chemical reactivity:

C = stable +4 & -4 oxidation state

Si & Ge = stable +4 oxidation state

Sn & Pb = stable +2 oxidation state

Due to the absence of d-orbitals carbon cannot expand its covalence more than 4.

GROUP 13 ELEMENTS

The stability of M^{+4} (or) +4 O.S decreases

i.e., $Ge^{+4} > Sn^{+4} > Pb^{+4}$

The stability of M^{+2} (or) +2 O.S increases

i.e., $Ge^{+2} < Sn^{+2} < Pb^{+2}$

Pb^{+4} is less stable, thus act as oxidising agent

$$Pb^{+4} + 2e^- \longrightarrow Pb^{2+}$$

Less stable — More stable

Element	Metallic Nature	Colour	Oxidation States
$_{6}C$	Non Metal	Black	+4,
$_{14}Si$	Non Metal	Light brown	+4,
$_{32}Ge$	Metalloid	Greyish white	+4, +2
$_{50}Sn$	Metal	Silvery white	+4, +2
$_{82}Pb$	Metal	Silvery white	+2, +4

Chemical Properties IVA group elements

i) Reactivity towards oxygen

They form two types of oxides with oxygen

a) Monoxides

$$2\,M + O_2 \xrightarrow{(\Delta)} 2\,MO$$

(limited)

Where, M = IVA group element

b) Dioxides

$$M + O_2 \xrightarrow{(\Delta)} M\,O_2$$

(excess)

Chemical Properties IVA group elements

i) Reactivity towards oxygen

Example:

SiO only exists at high temperature (weak acidic)

(monoxide)		(dioxide)	
CO	= (neutral)	CO_2	= (weak acidic)
GeO	= (acidic)	SiO_2	=
SnO	= (amphoteric)	GeO_2	=
PbO	=	SnO_2	= (amphoteric)
		PbO_2	=

MCQs

IVA GROUP ELEMENTS

Chemical Properties IVA group element

Oxidation state and treads in chemical reactivity:

C = stable +4 & -4

Si & Ge = stable +4

Sn & Pb = stable +2

Due to the absence of d-orbital's carbon cannot expand its covalence more than 4.

1. C- cannot exceed c … e…

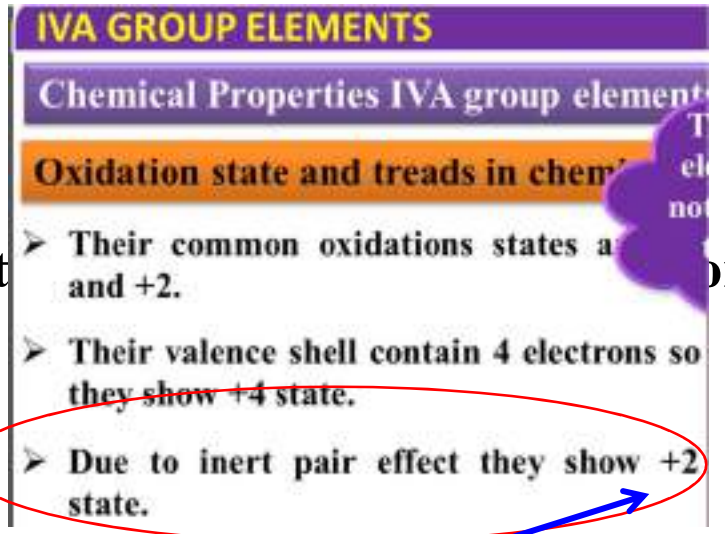
a) presence of d -orbital

b) absence of d -orbital

c) presence of p -orbital

d) absence of p -orbital

2. The element … on state is shown by…



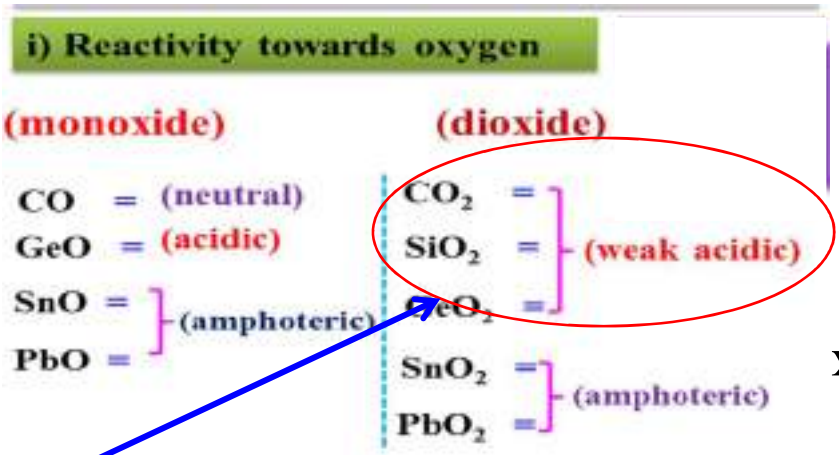
a) C

b) Ge

c) Sn

d) Pb

MCQs



3. Which IVA [illegible] xide?

a) C

b) Ge

c) Sn

d) Pb

Chemical Properties of IVA group elements (part-II)

Chemical Properties IVA group elements

ii) Reactivity towards water

In IVA group, only tin (Sn) reacts with boiling water to form dioxide and dihydrogen gas.

$$Sn + 2\,HOH \xrightarrow{(\Delta)} SnO_2 + 2\,H_2$$

(stannum) (water) (stannic oxide) (Di hydrogen)

NOTE : Lead is not affected by water due to an oxide film layer on the surface

Chemical Properties IVA group elements

iii) Reactivity towards halogen

These elements can form MX_2 and MX_4 type of halides except carbon

$$M + X_2 \xrightarrow{(\Delta)} MX_2$$

(limited) (di halide)

C and Si do not form stable dihalides

$$M + 2X_2 \xrightarrow{(\Delta)} MX_4$$

(excess) (tetra halide)

Chemical Properties IVA group elements

iii) Reactivity towards halogen

Heavier members Ge to Pb form MX_2.

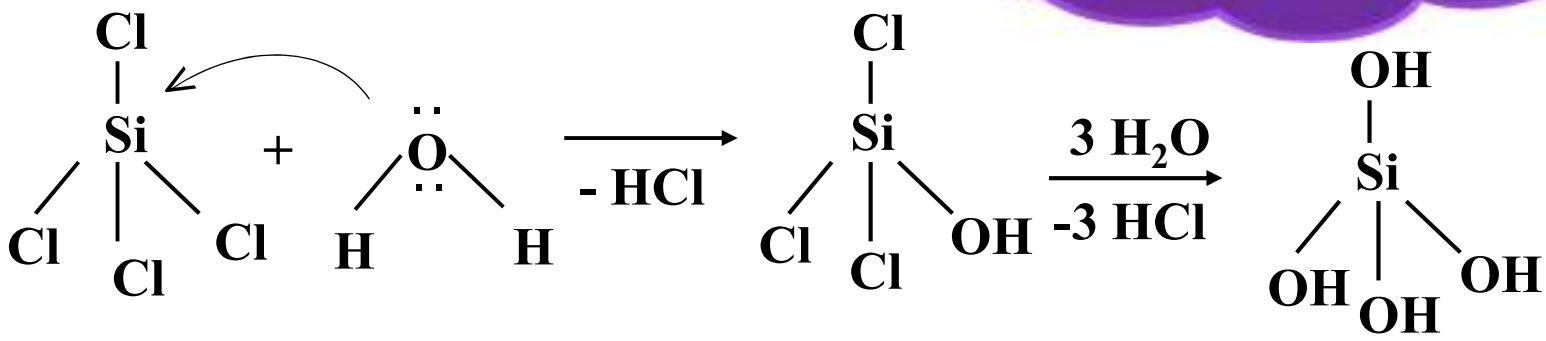
Tetra chlorides are easily hydrolyzed by water due to presence of d-orbitals except CCl_4 which

It happens because the central atom can accomodate the lone pair of electrons from oxygen atom of water molecule in d - orbitals

Chemical Properties IVA group elements

iii) Reactivity towards halogen

Hydrolysis can be understood by taking the example of $SiCl_4$



Chemical Properties IVA group elements

iii) Reactivity towards halogen

1.$[SiF_6]^{2-}$ is known where as $[SiCl_6]^{2-}$ not, give the reasons.

Ans:

- **6 large chloride ions cannot be accommodated around Si^{4+} due to the limitation of its size.**

- **Interaction between lone pair of Chloride ion and Si^{4+} is not very strong.**

MCQs

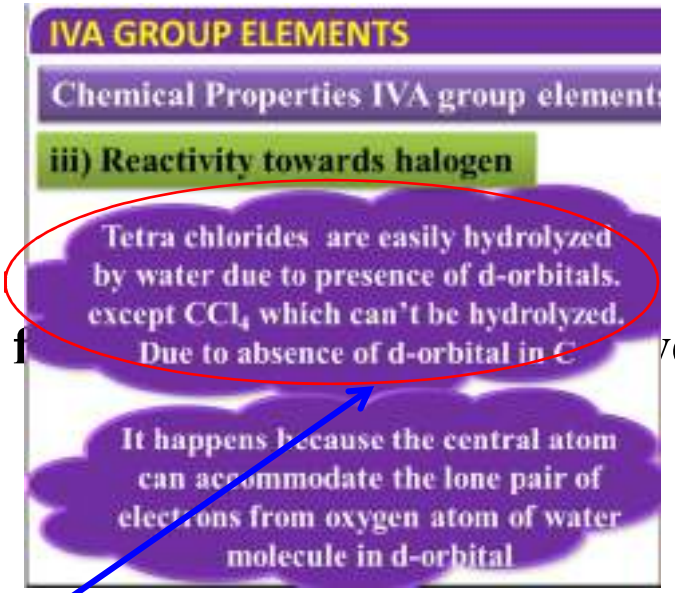
1.Why Pb is not affected by water?

a) Protective chloride layer formation

b) Protective oxide layer formation

c) Both A & B

d) None of the above



2. Which of the f ydrolysis?

a) $SiCl_4$

b) $PbCl_4$

c) CCl_4

d) $GeCl_4$

ANOMALOUS BEHAVIOUR OF CARBON

Anomalous behaviour of carbon

Why does carbon show anomalous behaviour?

Reasons

a) absence of d-orbitals.

b) very small Atomic size (77 pm).

c) very high Electro negativity (2.5).

d) very high Ionization enthalpy (1086 kJ/mol).

e) Presence of only two electrons in the penultimate shell

Anomalous behaviour of carbon

Elements	C	Si	Ge	Sn	Pb
At.Radii (pm)	77	118	122	140	146

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Elements	C	Si	Ge	Sn	Pb
I.E values KJ/mol	1086	786	761	708	715

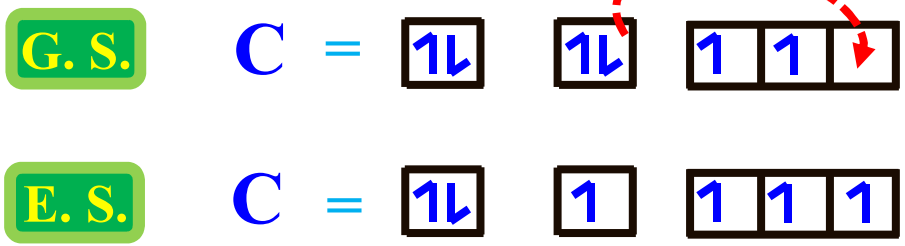
Important trends

Anomalous behaviour of carbon

Important trends

3) Due to the absence of d-orbital's, it has no tendency to form complex ions. As a result, its maximum covalency remains at 4.

$_{6}C =$ $1s^2$ $2s^2$ $2p^2$ (no d- orbital's)



Anomalous behaviour of carbon

Important trends

4) Carbon forms pπ – pπ multiple bonds with itself and others.

Example

$C = C$ $C \equiv C$ $C = O$ $C = S$ and $C \equiv N$

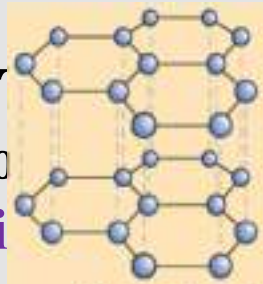
- Other elements do not form pπ – pπ bonds because their atomic orbitals are too large to diffuse.

Anomalous behaviour of carbon

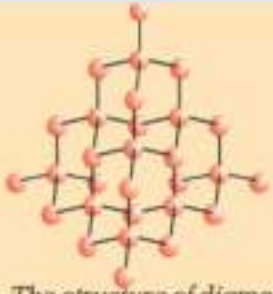
Important trends

5) Carbon shows a strong tendency of **catenation** by virtue of which it forms thousands of compounds. It happens because C[redacted]rong.

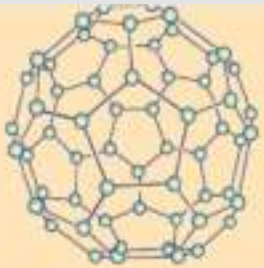
"[redacted]n element to fo[redacted]s of different si[redacted]".



The structure of graphite



The structure of diamond



The structure of C-60 Buckminsterfullerene

Anomalous behaviour of carbon

Important trends

5) Carbon shows a strong tendency of catenation by virtue of which it forms thousands of compounds. It happens because C – C bonds are very strong.

Down the group, the size increases and electro negativity decreases and thereby,
tendency to show catenation decreases.

It can be understood by bond enthalpy values.

Anomalous behaviour of carbon

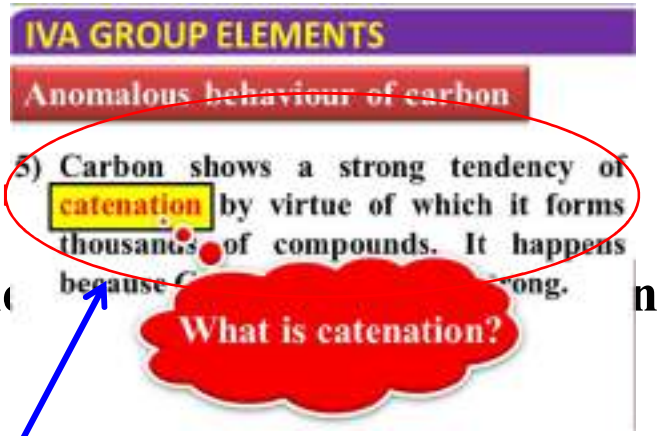
Bond enthalpy
(kJ/mol)

C - C	Si - Si	Ge - Ge	Sn - Sn	Pb - Pb
348	297	260	240	81

∴ **Order of Catenation = C >> Si > Ge ≈ Sn**

Whereas Lead does not show catenation.

MCQs



1. Which elem nation property?

a) B

b) Be

c) N

d) C

2. Which of the following ion does not exist?

a) $[SnF_6]^{2-}$

b) $[GeF_6]^{2-}$

c) $[SiF_6]^{2-}$

d) $[CF_6]^{2-}$

Allotropes of Carbon

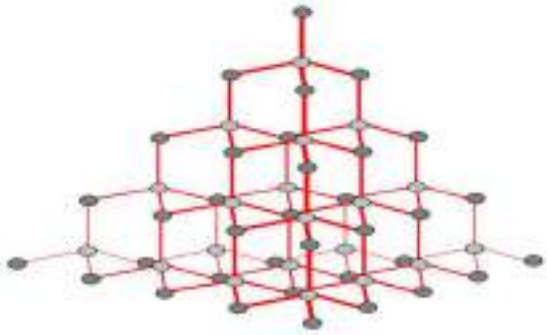
Due to catenation and pπ – pπ bond formation, carbon shows allotropic forms.

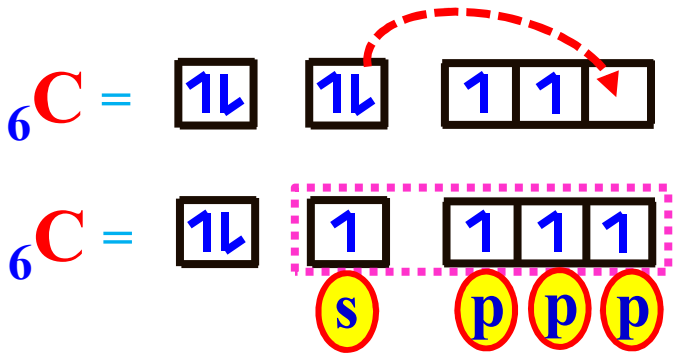
Diamond

Each Carbon is linked to 4 other carbons in tetrahedral fashion by covalent bonds.

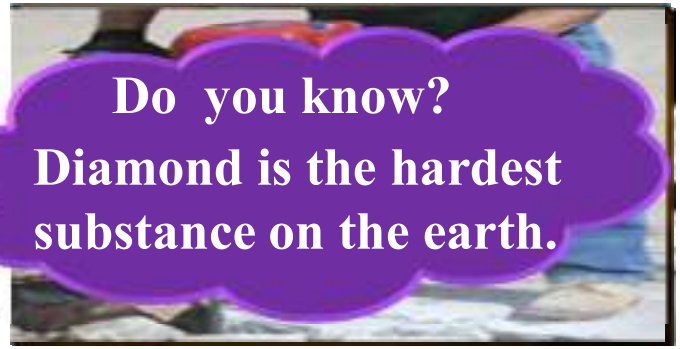
Diamond

- Since all four valence electrons of carbon are involved in bonding there is no free electron & so it is a bad conductor of electricity.





Diamond Uses



- Diamond as a precious stone and is us
  in jewellery & also in ornaments.
- Diamond is used as an abrasive for sharpening hard tools .
- Diamond is also used in the manufacture of tungsten filaments for electric bulbs.
- Diamond is used for making dyes & for rock drilling.

Diamond

Diamond is covalent, yet it has high melting point.why?

Diamond has 3D network involving strong C-C bonds,which are very difficult to break and, in turn has high melting point

IVA GROUP ELEMENTS

Due to catenation and pπ – pπ bond formation carbon show allotropic forms.

MCQs

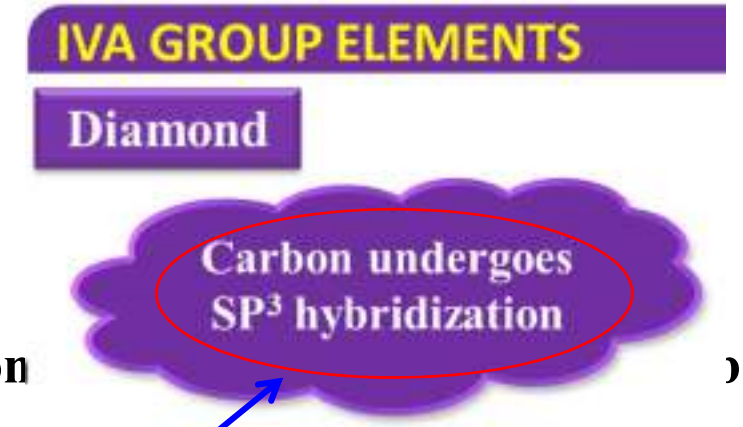
1. Carbon exhibi ecause…

a) catenation property

b) pπ - pπ bond formation

c) both a & b

d) none



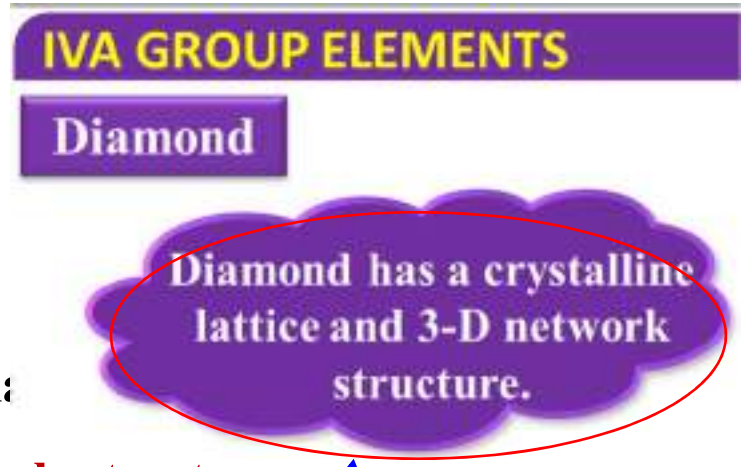
2. The carbon **ɔridisation**

a) sp

b) sp^2

c) sp^3

d) dsp^2



3. Why is di

a) covalent nature

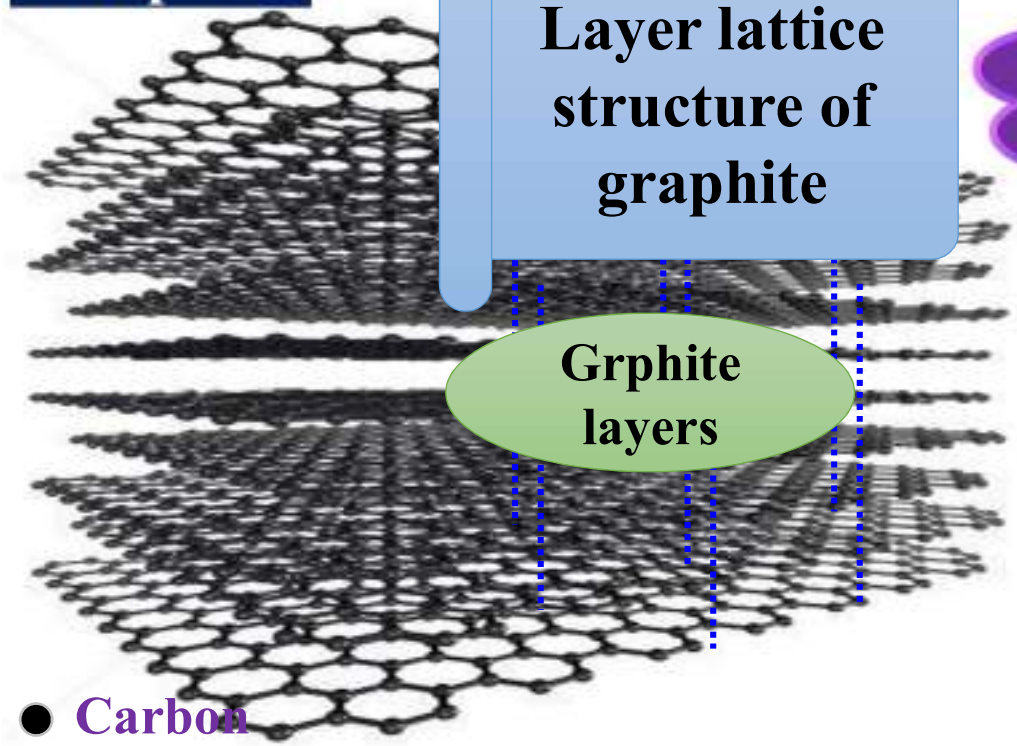
b) ionic nature

c) it is a giant molecule

d) crystalline lattice & 3-D network structure

Graphite

Graphite



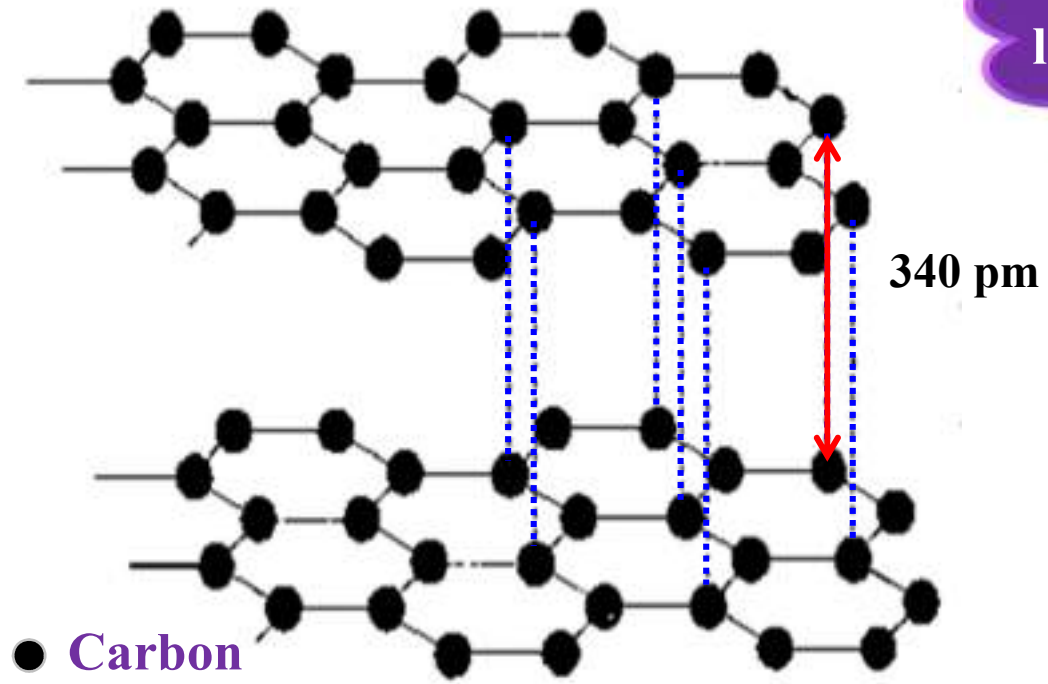
Layer lattice structure of graphite

Grphite layers

Layers are held by vanderwaal's forces of attraction.

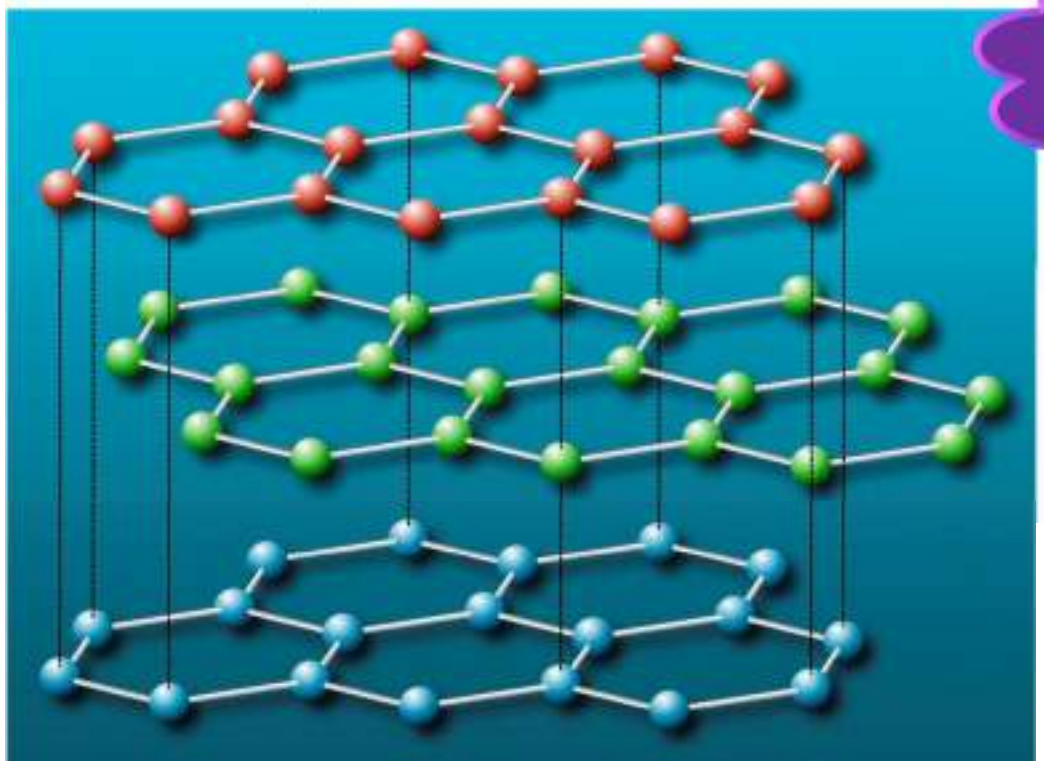
● **Carbon**

Graphite



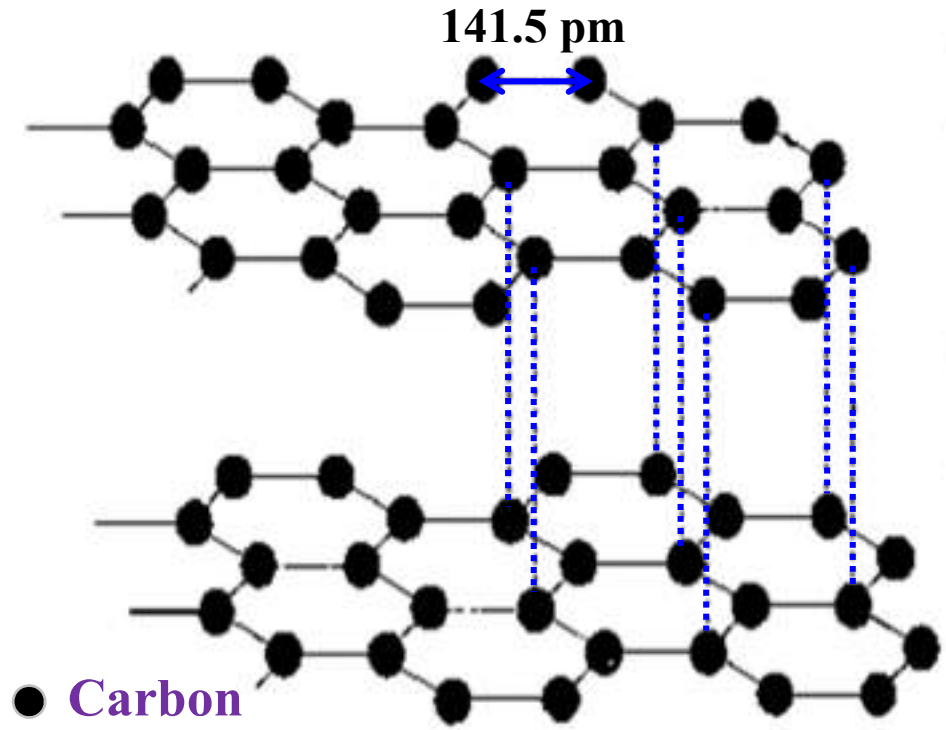
Distance between two layers is 340 pm or $3.40A^0$

Graphite



Each layer is composed of planar hexagonal rings of carbon atoms

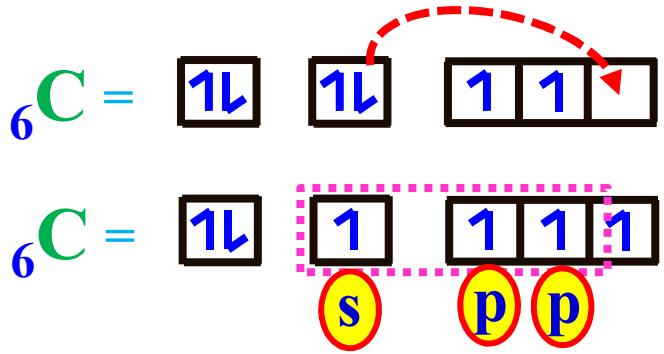
Graphite



C – C bond length within the layer is 141.5 pm or $1.415A^0$

Graphite

- In graphite each C-atom is sp^2 -hybridized.



- In graphite the fourth electron forms a π bond. The electrons are delocalised over the whole sheet & is mobile. So it is a good conductor of electricity.

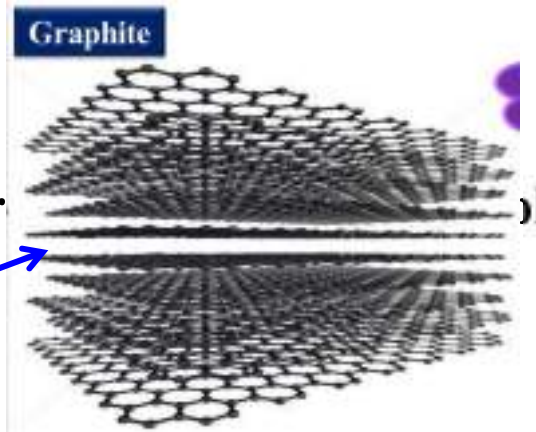
Graphite USES

- Graphite is soft & slippery. So, used as a dry lubricant instead of oil.
- As graphite can conduct electricity, it is used to prepare electrodes.

Graphite rod

- When mixed with wax or clay, graphite is used to make cores of lead pencils.
- Graphite is also used in the manufacture of dry cells & batteries.

MCQs

1. **Hybridization and structur** 

hite is…

a) sp^3, layered structure

b) sp^2, layered lattice structure

c) sp^2, network crystalline

d) sp^3, network crystalline

Graphite

- When mixed with wax or clay, graphite is used to make cores of lead pencils.

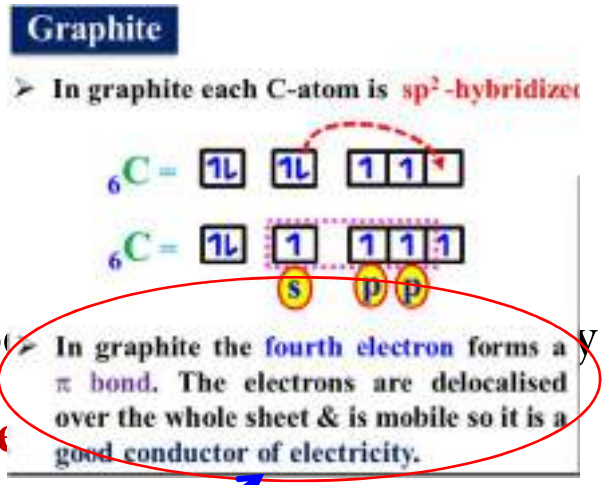
2. Lead pencil

a) Pb

b) carbon

c) Graphite & clay

d) C - diamond



3. Graphite is a go y due to the presence of...

a) crystalline

b) sp^2 hybridised carbon

c) free electrons

d) Free atoms

4. The C-C bond length and the distance between adjacent layers in graphite are respectively.

a) 1.54A^0, 3.35A^0

b) 1.4A^0, 2.35A^0

c) 1.415A^0, 3.35A^0

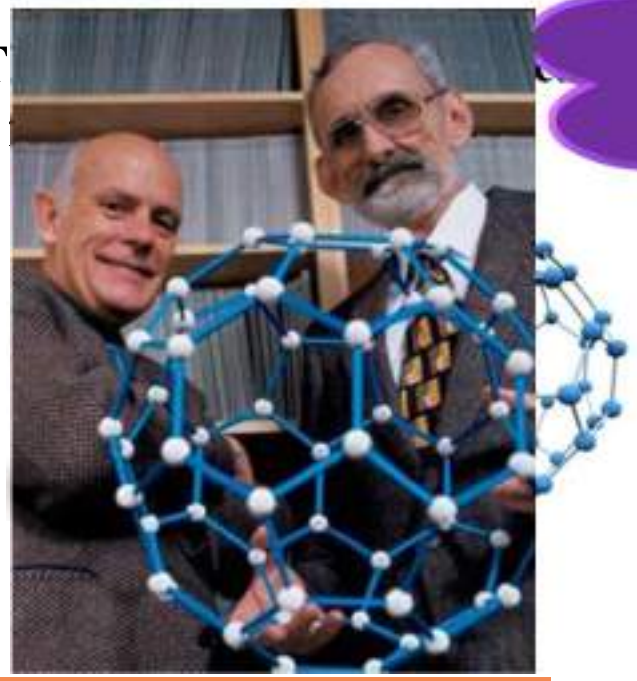
d) 3.35A^0,1.42A^0

FULLERENES

Fullerenes

"T

as

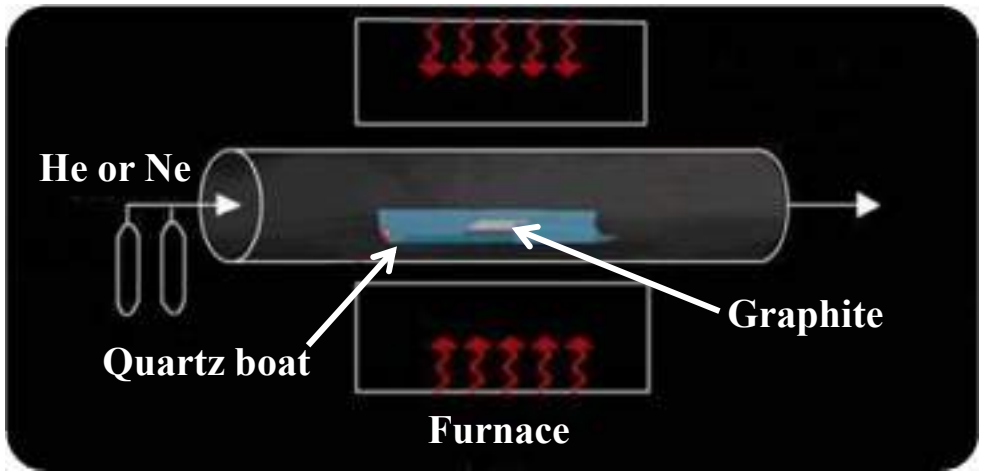


Kroto Smalley and Curt

Kroto Smalley and Curt, got Nobel Prize for the discovery of Fullerenes which is a crystalline allotrope of carbon

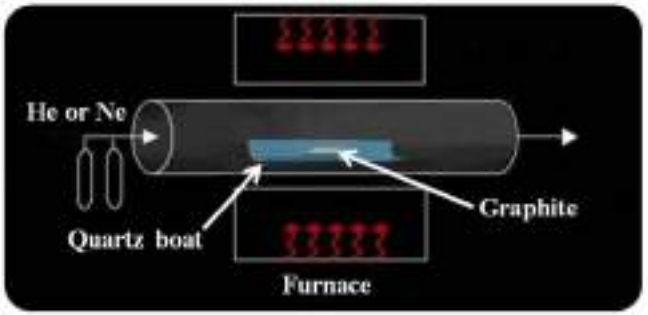
Fullerenes | Preparation

When graphite is heated in an electric arc in an inert atmosphere (He or Ne) a sooty material formed by condensation of vapourised "C_n" molecules are known as fullerenes.

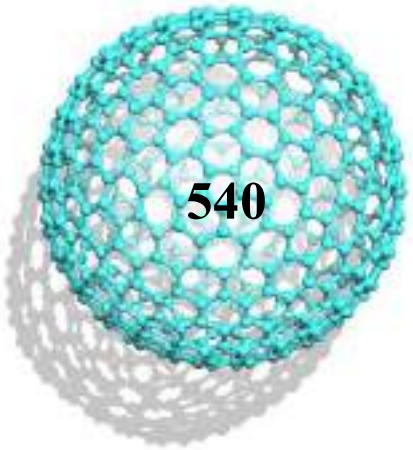


Fullerenes

Preparation



Major quantity is of C_{60} , traces of C_{70} and traces of fullerenes consisting of even number of carbon atoms upto 350 or above, like C_{540}.



Fullerenes

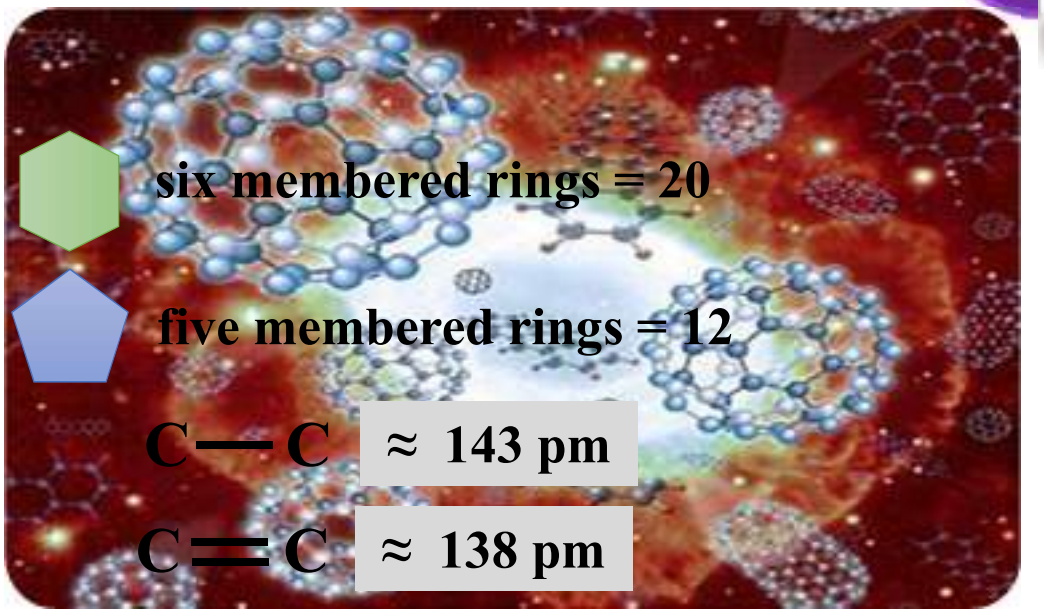
- Fullerenes being covalent are readily soluble in organic solvents.
- Fullerenes react with group 1 metals forming K_3C_{60} solid which behave as a super conductor below 18 K.

::Note::

Superconductivity is a phenomenon of exactly zero electrical resistance and expulsion of magnetic fields occurring in certain materials when cooled below a characteristic critical temperature.

Fullerenes

- C_{60} molecule has a shape likes soc
  ball, and called *Buckminsterfullerene*



Fullerenes

::Note ::

- six membered ring is fused with six or five membered ring but a five membered ring can only be fused with five membered ring.

Fullerenes

- Carbon atoms undergo SP^2 hybridization.
- Each C forms 3 sigma bonds with other carbons.
- The remaining electron is responsible for aromatic character.
- They have 60 vertices. And each one is occupied by one carbon.

::Note ::

Graphite is thermodynamically most stable allotrope of carbon. Therefore ΔH_f of graphite is taken as zero and for diamond and fullerenes have 1.9 and 38.13 kJ mole^{-1} respectively.

MCQs

1. Formula of first well known Bucky ball is …

a) C_{40}

b) C_{50}

c) C_{60} ✓

d) C_{70}

2. Structure of the fullerene…

a) cricket ball

b) Volley ball

c) Tennis ball

d) Soccer football

Fullerenes

- C_{60} molecule has a shape likes soccer ball, and called Buckminsterfullerene or Bucky balls

Fullerenes

- C_{60} molecule has a shape likes soccer ball, and called Buckminsterfullerene or Bucky balls
- It consist...
  - six membered rings = 20
  - five membered rings = 12

3. How many [illegible]mbered rings are present in C_{60} respec[illegible]

a) 20,12

b) 20,15

c) 12,20

d) 15,20

4. The carbon in Diamond, graphite, fullerenes undergo_____ hybridisation

a) sp^3, sp^2, sp^2

b) all are sp^3

c) all are sp^2

d) sp^3, sp^2, sp

CHEMICAL PROPERTIES OF CARBON

Chemical properties of carbon

1) Action of oxygen :

$$2C_{(s)} + O_{2(g)} \xrightarrow{(\Delta)} 2CO_{(g)}$$

limited

(Carbon monoxide)

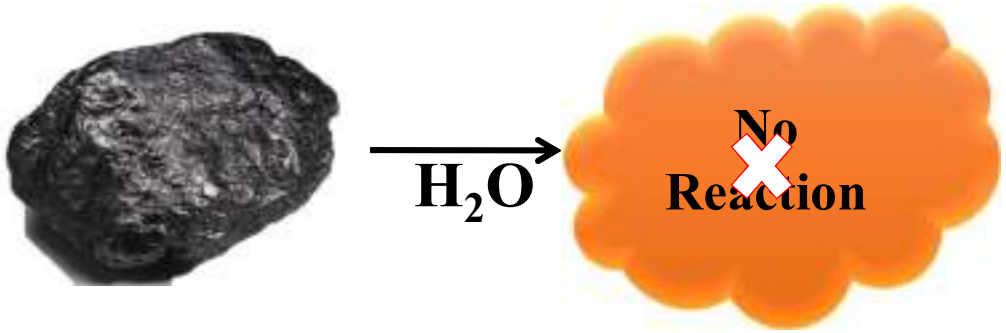
$$C_{(s)} + O_{2(g)} \xrightarrow{(\Delta)} CO_{2\,(g)}$$

excess

(Carbon dioxide)

Chemical properties of carbon

2) Action of Water at room temperature:



Chemical properties of carbon

3) Action of halogens :

$$C_{(s)} + 2X_2 \xrightarrow{(\Delta)} CX_4$$

E.g. :

CF_4 , CCl_4 , CBr_4 , CI_4 .

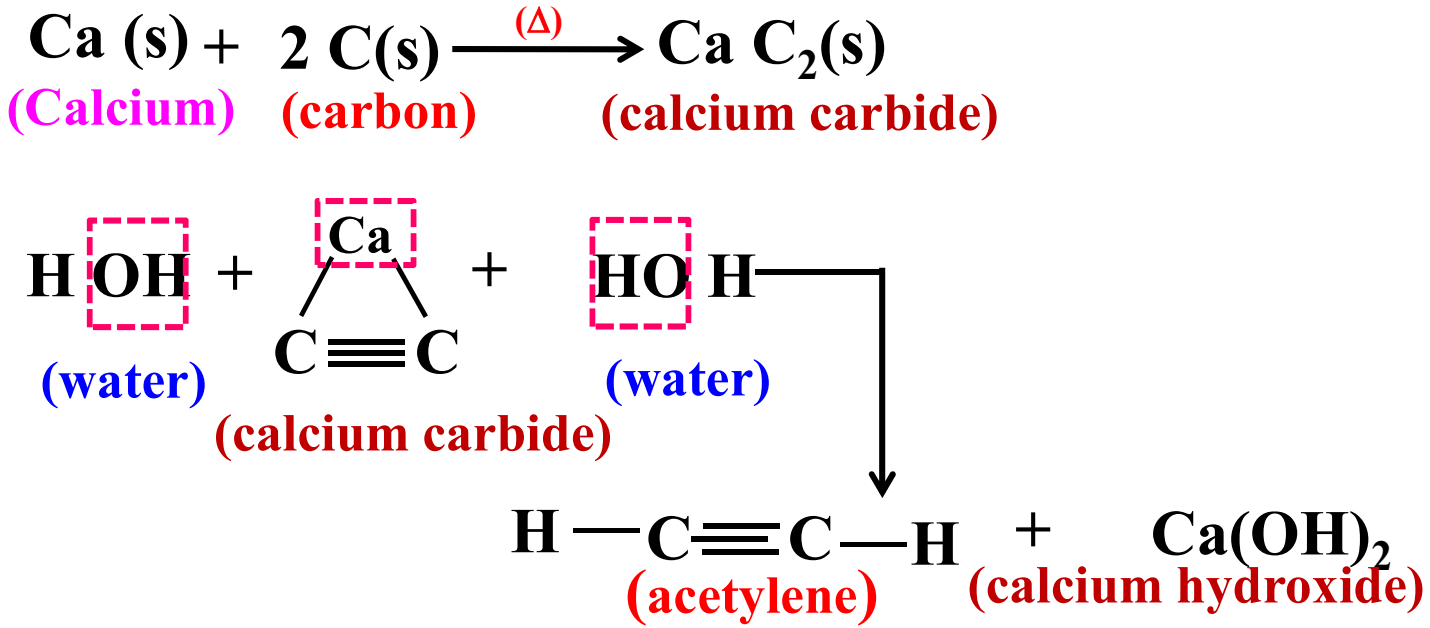
also, CF_2 , CCl_2 , $CHCl_3$, CH_2Cl_2 etc.

CCl_4 = Pyrene (trade name)
(fire extinguisher)

CF_2Cl_2 = Freon (refrigerant)

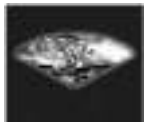
Chemical properties of carbon

4) Formation of carbides



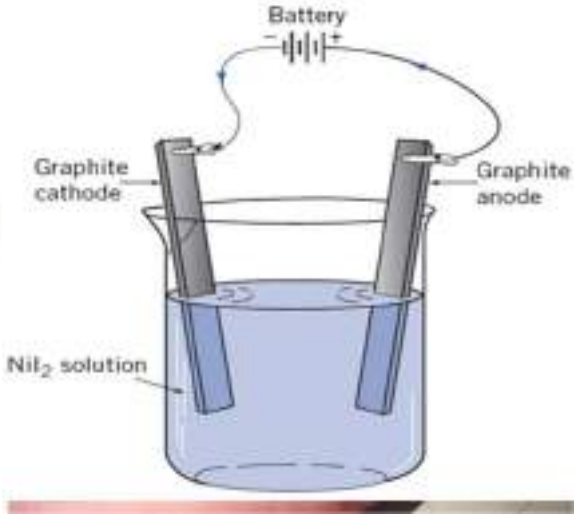
Uses of carbon:

a) Diamond



- It is a precious stone used in jewellery.
  (1 carat = 200 mg)

b) Graphite



- Used as electrodes in batteries & also in industrial electrolysis.

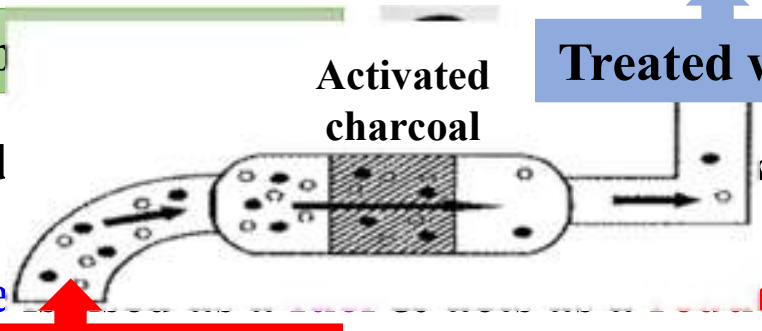
- Used to prepare crucibles in laboratory as they are inert towards acids & alkalies.

Uses of carbon:

c) Charcoal

- **Activated charcoal is used as a good adsorbent for adsorbing poisonous gases & removing coloring impurities from water.**

d) Carb



- **Used** **& pigments.**
- **Coke** **cing agent in metallurgy.**

Uses of carbon:

c) Charcoal

- Activated charcoal is used as a good *adsorbent* for adsorbing poisonous gases & removing coloring impurities from water.

MCQs

1. Poisonous gases are removed by…

a) carbon black

b) charcoal ✓

c) graphite

d) coke

Uses of carbon:

a) Diamond

- It is a precious stone used in jewellery.
  (1 carat = 200 mg)

2. Quality of the diamond is measured in…

a) carat = 200mg

b) carat = 200g

c) carat = 20g

d) carat = 20mg

3. Being a good conductor, graphite is used as..

a) electrodes in batteries

b) electrodes in industrial electrolysis

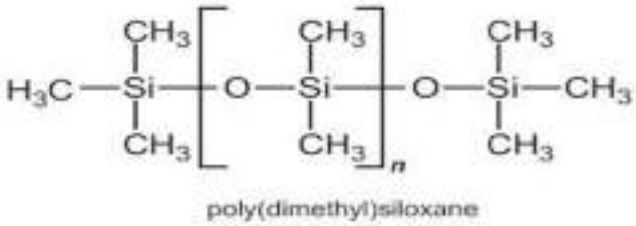
c) crucibles in laboratory

1. a,b **2. b,c** **3. c,a** **4. a,b,c**

SILICONES

Silicones

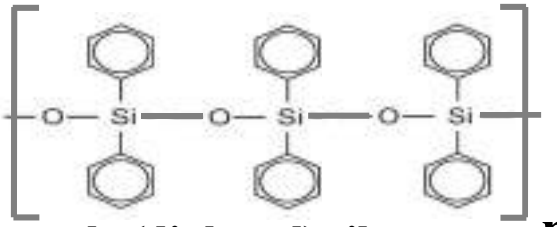
- "Silicones are synthetic organo silicon polymers containing repeating units R_2SiO held by Si – O – Si linkages".



poly(dimethyl)siloxane

Empirical formula ⟹ R_2SiO

Where R can be alkyl(ex: methyl-CH_3)or aryl (phenyl-C_6H_5)



poly (diphenyl) siloxane

➢ What are silicones ?

Simple silicones consist of  **chains in which alkyl or phenyl**

groups occupy the remaining bonding positions on each silicon.
They are hydrophobic (water repellant) in nature

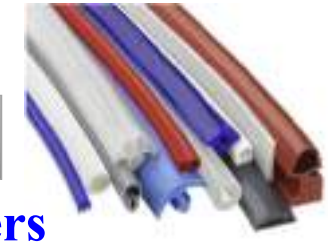
Types of silicones

Silicones

- **Short chain** → **oily liquids**

- **medium chain** → **viscous oils, jellies & greases**

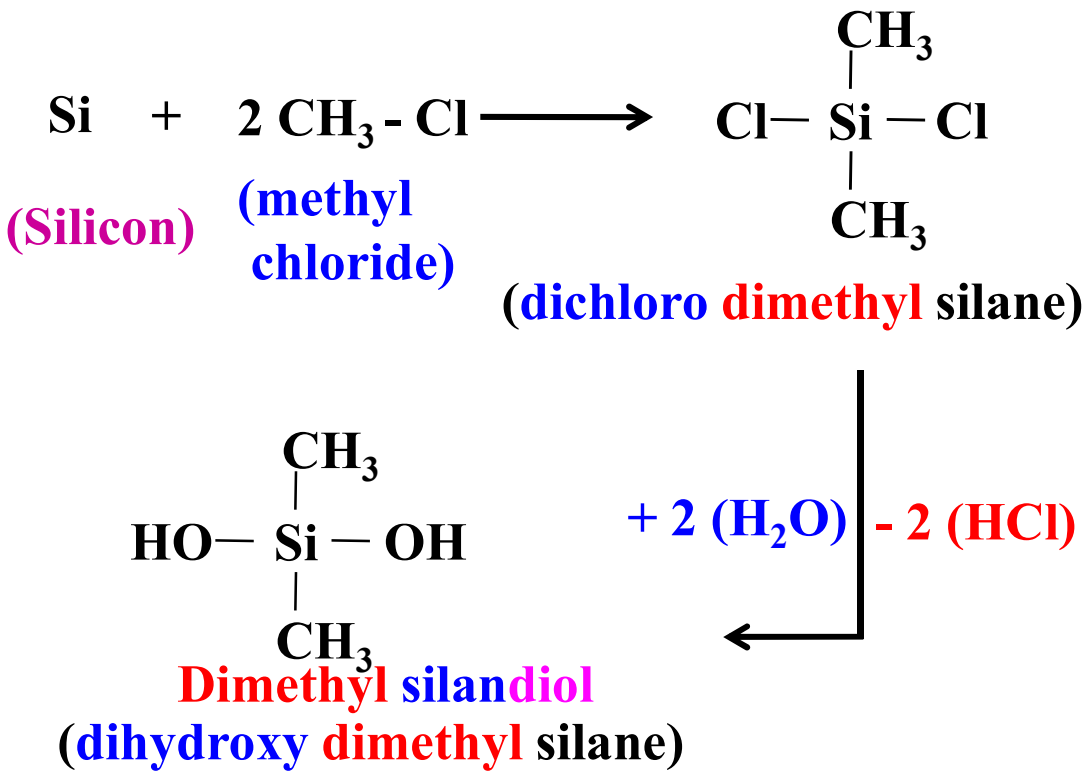
- **Long chain** → **rubbery Elastomers & resins**



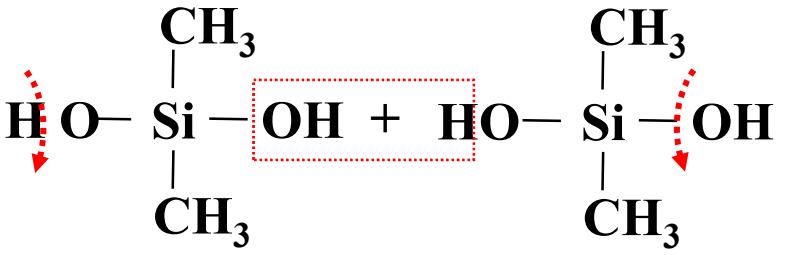
Preparation of silicones

- **The starting material for the manufacture of silicones are *alkyl or aryl substituted silicon chlorides* ($R_nSiCl_{[4-n]}$).**
- **Methyl chloride reacts with silicon in the presence of copper as a catalyst at 573K to form methyl substituted chlorosilane.**
- **Hydrolysis of dimethyldichlorosilane $(CH_3)_2SiCl_2$ followed by condensation polymerization gives straight chain polymers.**
- **$RSiCl_3$ used for preparation of cross linked silicone.**
- **The chain length of silicone polymer can be controlled by adding R_3SiCl**

Preparation of silicones | Step – I | Initiation



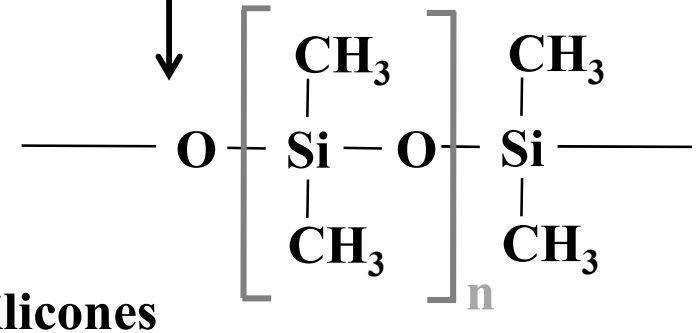
Preparation of silicones | Step – II | Propagation



(dihydroxydimethyl silane molecules)

- (H_2O)

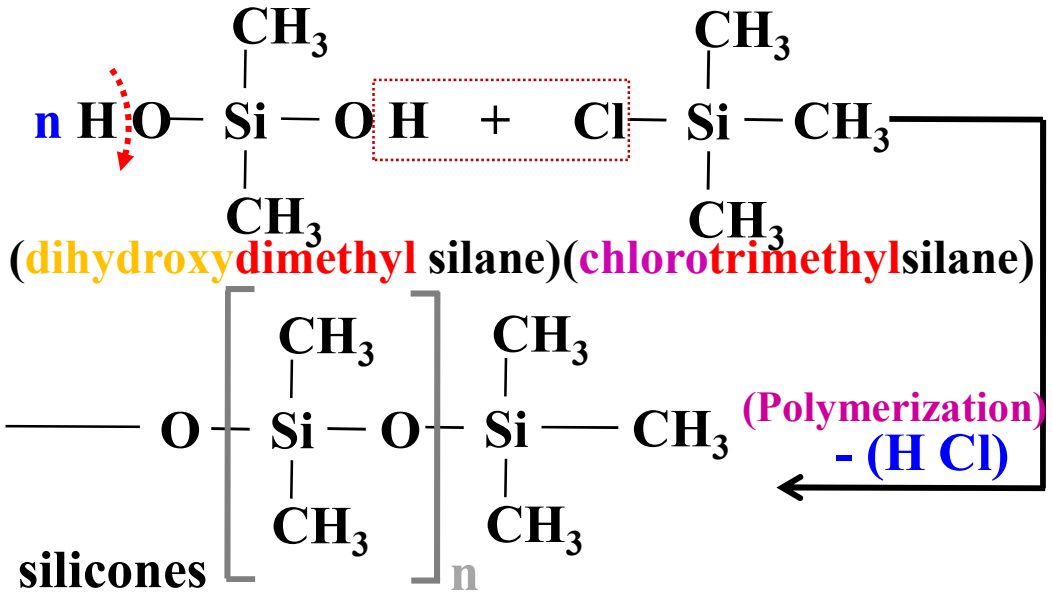
(Polymerization)



silicones

Preparation of silicones | Step – III | Termination

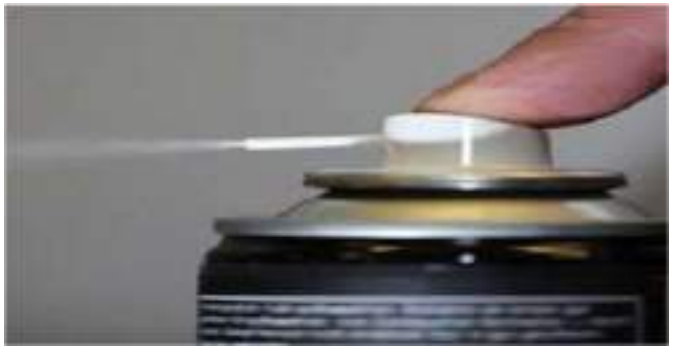
The chain growth of the polymer can be controlled by adding chloro trimethyl silane .



Uses of silicones

- **Silicones are used in textiles and also to prepare water proof papers .**

- **Silicones are used as lubricants at high and low temperatures .**



- **Silicones are also used as a sealant,**

- **Greases:**

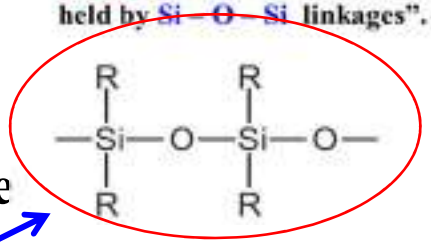
- **Electrical insulation**

- **Because of its biocompatibility, it plays an important role in surgical and cosmetic plants .**

MCQs

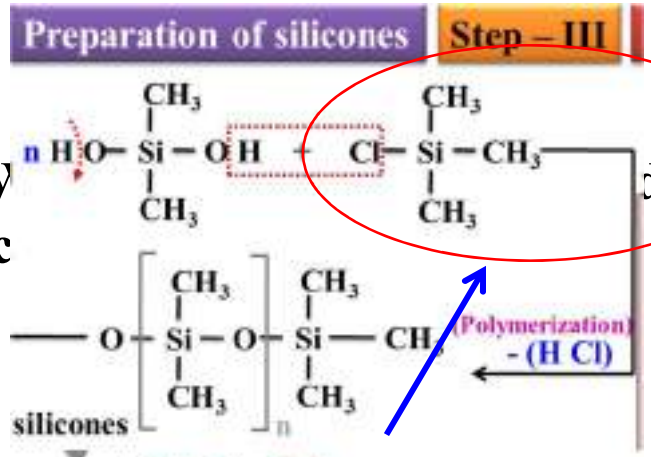
Silicones

- "Silicones are synthetic organo silicon compounds containing repeated units held by Si—O—Si linkages".



1. What is the ge s?

a) $+R_2\ SiO+$
b) $+R_2\ SiO_2+$
c) $+R\ SiO_2+$
d) $+R\ SiO+$



2. V **d to terminate the**
c

c) $(CH_3)_4$ Si

d) CH_3SiCl_3

SILICATES & ZEOLITES

Silicates

"Silicates are the oxo-anions of silicon having SiO_4^{4-} units forming a tetrahedral geometry".

Sources of silicates

Rocks

Clay

Soil

Silicates

- **A large number of silicate minerals exist in nature. Some important minerals are mentioned below:**

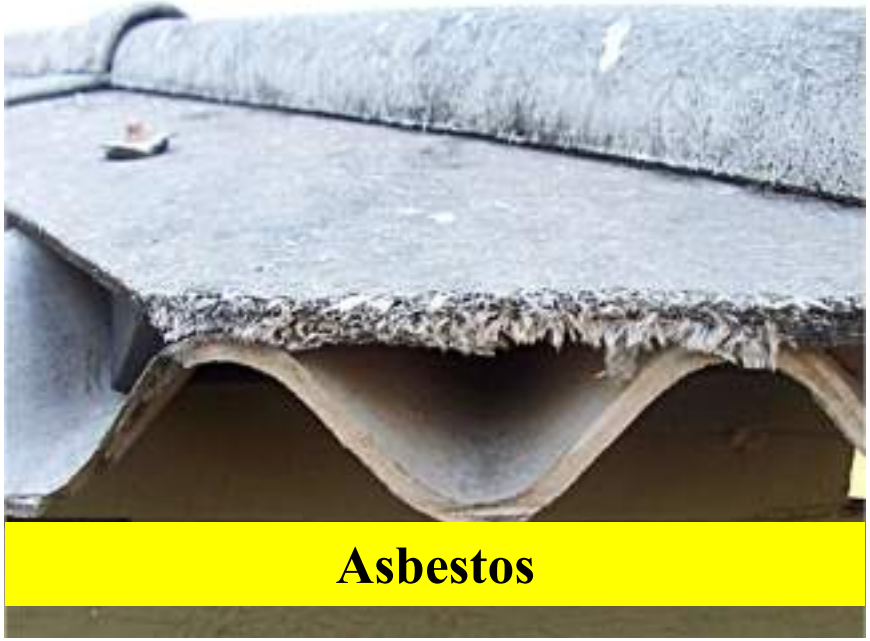
Examples: **1) Feldspar**

2) Mica

Mica

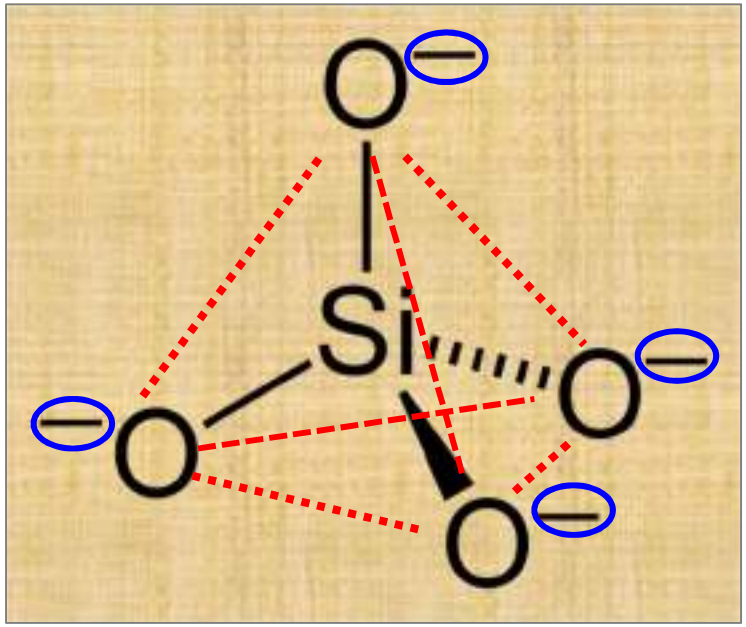
3) Zeolites

4) Asbestos



Silicates Structure

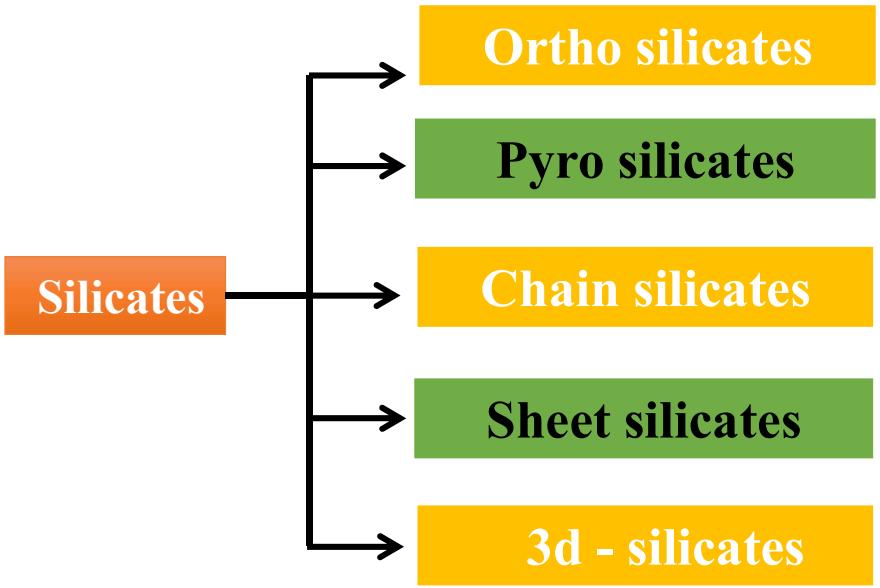
SiO_4^{4-} has tetrahedral geometry .

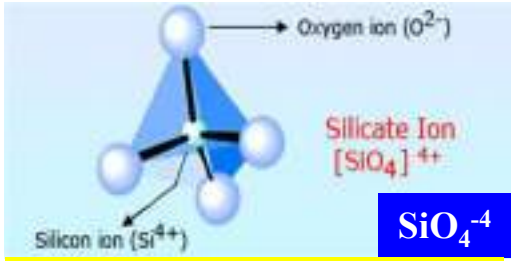


The basic structural unit of silicates is SiO_4^{4-}

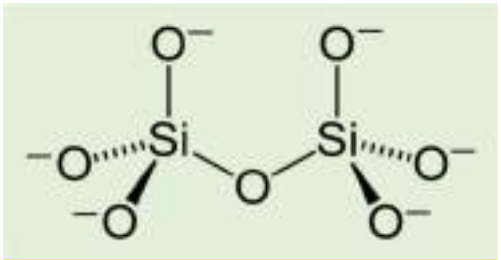
Silicates Types

- Depending on the number of corners of SiO_4^{4-} units shared silicates are classified as:

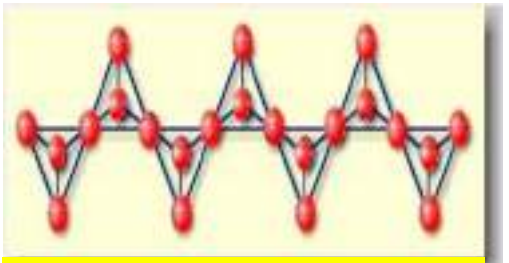




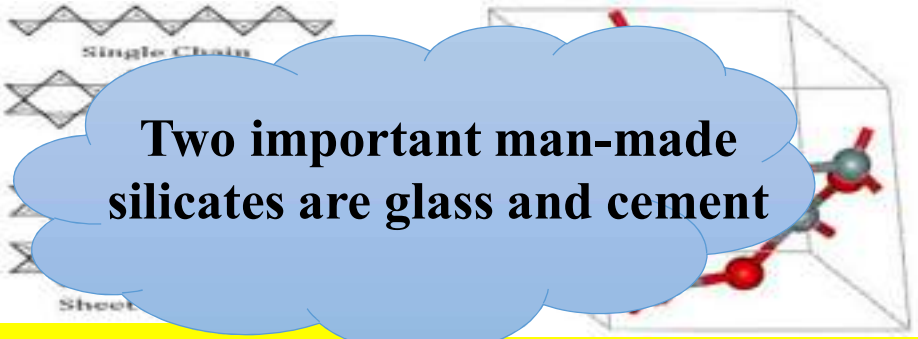
1) Ortho silicates



2) Pyro silicates



3) Chain silicates



Two important man-made silicates are glass and cement

4) Sheet silicates

5) 3-d silicates

GROUP 13 ELEMENTS

Ortho silicate SiO_4^{4-}

Pyro silicate $Si_2O_7^{2-}$

Chain silicate $(SiO_3)_n^{-2}$

Cyclic silicate $Si_3O_9^{6-}$

Sheet Silicates : -

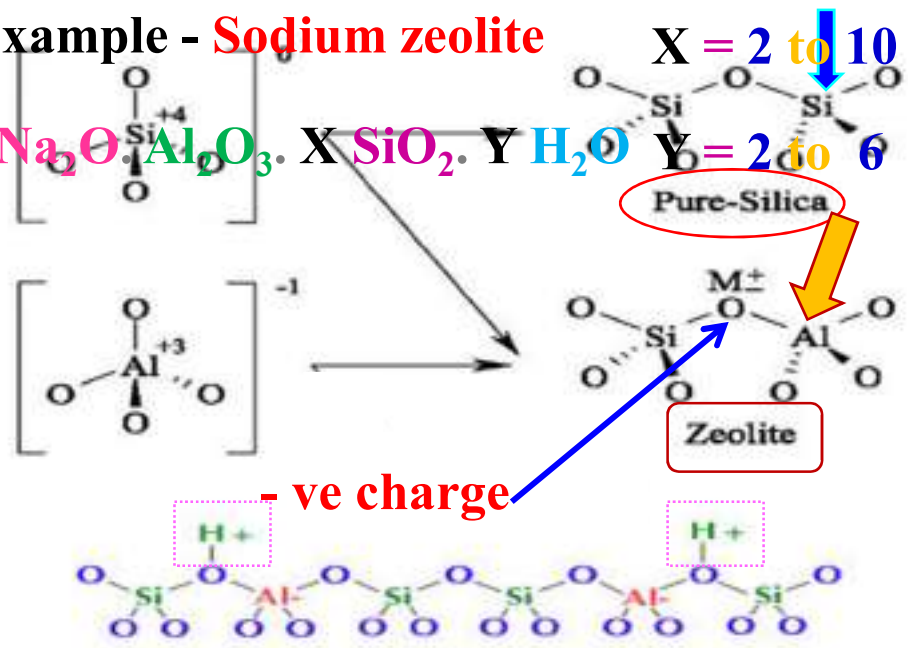
Here "3" oxygen atoms of each SiO_4 tetrahedral units are shared

Frame work Silicates :

Here "4" oxygen atoms of each SiO_4 tetrahedral units are shared

Zeolites

Example - Sodium zeolite



icon atoms from a three
overall structure known as
a negative charge .

Zeolites **Types**

- **Natural**
- **Synthetic**

Zeolites Application

- **It is used for *cracking of hydrocarbons* and *isomerization.***
- **ZSM – 5 is used to convert *alcohols directly into gasoline.***
- **Hydrated zeolites are used as *ion exchangers in softening of "hard water".***

Fuel Gases : -

	Fuel Gas	Composition	Calorific value
1)	Watergas (Synthesis gas)	CO = 40 – 50% H_2 = 45 – 50%	13000 KJ / m^3 Endo thermic
2)	Producer gas	CO = 33% N_2 = 64% remaining CO_2 & H_2	5439.2 KJ / m^3 Exo thermic
3)	Semi water gas	CO + N_2 + H_2 + CH_4	7524 KJ / m^3
4)	Carburetted Watergas	CO + H_2 + Hydrocarbons	

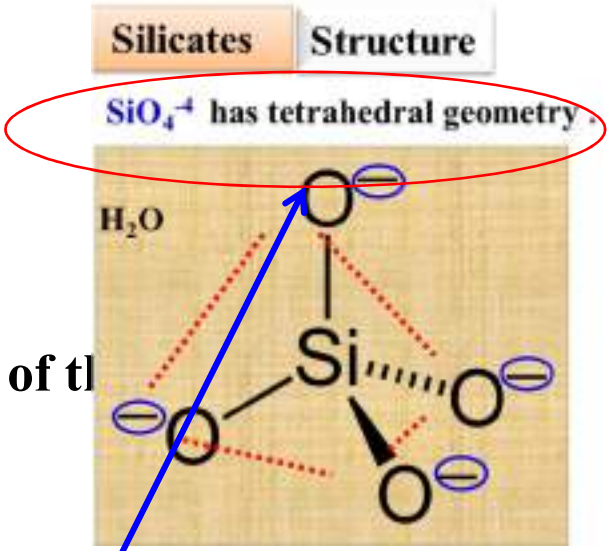
GROUP 13 ELEMENTS

Calorific values :-

Coal gas > Carburatted water gas > water gas > Semi watergas > Producer gas

(H_2 gas major) (N_2 gas major)

MCQs



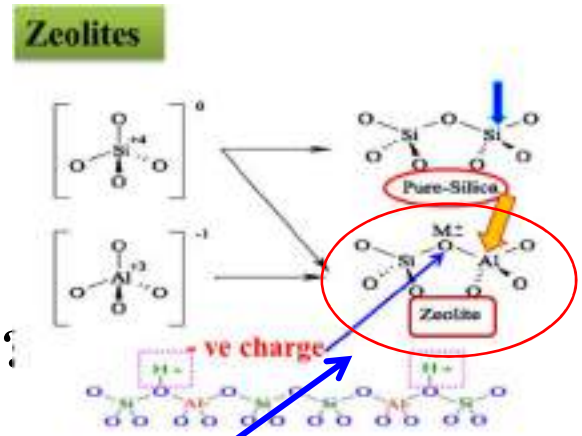
1. The structure of tl

a) Linear

b) Angular

c) Square planar

d) Tetrahedral



2. What are zeolites?

a) Alumino silicates

b) Boron silicates

c) Berilium silicates

d) Magnesium silicates

3. Zeolites are…

a) Negatively charged

b) Positively charged

c) Neutral species

d) All of the above

4. Zeolites are used …

a) In cracking of hydro carbons

b) as ion exchangers in softening of hard water

c) in the isomerisation of hydrocarbons

d) in the conversion of alcohols to gasoline

1) a, b, c **2) b, c, d**

3) d, a, b **4) a,b,c,d** ✓

IVA GROUP ELEMENTS

PREVIOUS COMPETATIVE QUESTIONS

PCQS

1) The gas evolved on heating CaF_2 and SiO_2 with concentrated H_2SO_4, on hydrolysis gives a white gelatinous precipitate. The precipitate is : [J.M.O.L – 2014]

1) Hydrofluosilicic acid
2) Silica gel
3) Silicic acid ✓
4) Calcium fluorosilicate

2) Example of a three-dimensional silicate is : [J.M.O.L – 2014]

1) Zeolites

2) Ultramarines

3) Feldspars

4) Beryls

3) Amongst the following, identity the species with an atom in +6 oxidation state : [J.M.O.L – 2014]

1) $[MnO_4]^-$

2) $[Cr(CN)_6]^{3-}$

3) Cr_2O_3

4) CrO_2Cl_2

4) Which one of the following elements reacts with steam? [E – 2014]

1) Ge

2) Si

3) Sn

4) C

5) The major product formed when 1, 1, 1-trichloro-propane is treated with aqueous potassium hydroxide is : [J.M.O.L – 2014]

1) Propyne
2) 1 Propanol
3) 2 - Propanol
4) Propionic acid

6) Which of the following exists as a covalent crystals in the solid state ?
[JEE – 2013]

1) Iodine

2) Silicon ✓

3) Sulphur

4) Phosphorus

7) Identify the incorrect statement : [J.M.O.L – 2013]

1) In $(Si_3O_9)^{6-}$, tetrahedral SiO_4 units share two oxygen atoms

2) Tri alkyl chloro silane on hydrolysis gives R_3SiOH

3) $SiCl_4$ undergoes hydrolysis to gives H_4SiO_4

4) $(Si_3O_9)^{6-}$ has cyclic structure

8) How many corners of SiO_4 unit are shared in the formation of three dimensional silicates ? [E – 2013]

1) 3

2) 2

3) 4

4) 1

9) Assertion (1) : GeF_4 & $SiCl_4$ act as Lewis bases [M – 2013]

Reason (R) : Ge and Si have d- orbitals to accept electrons

1) Both A and R are correct and R is the correct explanation of A.

2) Both A and R are correct but R is not the correct explanation of A.

3) A is True but R is False

4) R is True but A is False

10) The catenation tendency of C, Si and Ge is in the order Ge<Si<C. The bond energies (in Kjmol^{-1}) of C-C, Si-Si and Ge-Ge bonds are respectively : [J.M.O.L – 2013]

1) 348, 297, 260

2) 297, 348, 260

3) 348, 260, 297

4) 297, 260, 348

11) The reaction that gives CO_2 as one of the products is **[EAMCET-2012]**

1) $3C + 4HNO_3 \xrightarrow{\Delta}$

2) $6NaOH + 2C \longrightarrow$

3) $SnO_2 + 2C \longrightarrow$

4) $Fe_2O_3 + 3C \xrightarrow{250^0,400^0C}$

12) What is the empirical formula of sheet silicates ? [EAMCET-2011]

1) $(Si_2O_5)_n^{2n-}$

2) $(SiO_3)_n^{2n-}$

3) $(SiO_3)_n^{n-}$

4) $(Si_2O_7)_n^{3n-}$

13) Extraction of metal from the ore cassiterite involves?
[IIT JEE -2011]

1) Carbon reduction of an oxide ore

2) Self- reduction of a sulphied ore

3) Removal of copper impurity

4) Removal of iron impurity

14) Producer gas is the mixture of **[JCECE - 2011]**

1) $CO + N_2$

2) $CO + H_2$

3) CO + water vapour

4) $N_2 + CH_4$

15) Dry ice is .. **[UPSEE - 2009]**

1) Solid H_2O

2) Solid CO_2

3) Solid N_2O_4

4) Solid NH_3

16) In feldspar and zeolite, Si^{4+} ions are replaced by which ions ?
[GUJ cet - 2009]

1) Oxide ion

2) Hydroxide ion

3) Aluminium ion

4) Potassium ion

17) What product is formed on heating lead nitrate ?

[OJEEE – 2009]

1) $PbO + NO + O_2$

2) $PbO + NO_2 + O_2$

3) $Pb + NO_2$

4) $PbO + N_2$

18) Among the following substituted silanes the one which will give rise to cross linked silicone polymer on hydrolysis is ? [AIEEE-2008]

1) R_2SiCl_2

2) $RSiCl_3$

3) R_2SiCl

4) R_4Si

19) Identify B in the following reaction [EAMCET-2008]

1) Carborundum

2) Quartz

3) Kiesulguhr

4) Sand stone

20) Hydrolysis of $SiCl_4$ gives compound x and HCl, on heating to 1000^0C X looses water and forms Y. Identify X and Y respectively

[EAMCET-2008]

1) H_2SiO_4 and SiO_2

2) SiO_2 and Si

3) SiO_2 and SiC

4) H_2SiO_4 and SiC

21) White lead is **[EAMCET-2008]**

1) $PbCO_3PbO$

2) $PbCO_3$

3) $Pb(OH)_2\ 2PbCO_3$

4) $PbSO_4PbO$

22) Which of the following oxides is amphoteric in character ?

[UPSEE - 2008]

1) SnO_2

2) SiO_2

3) CO_2

4) CaO

23) Roasted tin stone ore after washing with water is known as **[Manipal - 2008]**

1) Block tin

2) White tin

3) Black tin

4) Granulated tin

24) A fibrous mineral which can withstand red hot flames without any damage is [Manipal - 2008]

1) Tale

2) Glass wool

3) Soap stone

4) Asbestos

25) The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence **[AIEEE - 2007]**

1) $PbX_2 < SnX_2 < GeX_2 < SiX_2$

2) $GeX_2 < SiX_2 < SnX_2 < PbX_2$

3) $SiX_2 < GeX_2 < PbX_2 < SnX_2$

4) $SiX_2 < GeX_2 < SnX_2 < PbX_2$

26) Which glass has the highest percentage of lead ? [BITSAT - 2007]

1) Soda glass

2) Flint glass

3) Jena glass

4) Payrex glass

27) Which of the following is used in making printer's ink, shoe polish, black varnish and paint ? [WB JEE - 2007]

1) Lamp black

2) Bone black

3) Carbon black

4) None of these

28) A metal , M forms chlorides in its +2 and +4 oxidation states. Which of the following statements about these chlorides is correct ?

[AIEEE - 2006]

1) MCl_2 is more volatile than MCl_4

2) MCl_2 is more soluble in the anhydrous ethanol than MCl_4

3) MCl_2 is more ionic than MCl_4

4) MCl_2 is more easily hydrolysed than MCl_4

29) What is X in the following reaction ?

$SiCl_4 + H_2O \longrightarrow X + HCl$ [EAMCET - 2006]

1) H_4SiO_4

2) SiH_4

3) $(SiOOH)_2$

4) $Si(ClO_4)_4$

30) Which of the following is used for making optical instruments
[EAMCET - 2006]

1) SiO_2

2) Si

3) SiH_4

4) SiC

31) Which of the following oxides is amphoteric in character ?
[AIEEE - 2005]

1) CaO

2) CO_2

3) SiO_2

4) SnO_2

32) The number and type of bonds between two carbon atoms in calcium carbide are ? [AIEEE - 2005]

1) One sigma, one pi

2) One sigma, two pi

3) Two sigma one pi

4) Two sigma, two pi

33) SiO_2 is reacted with sodium carbonate. What is the gas liberated ?
[EAMCET - 2005]

1) CO

2) O_2

3) CO_2

4) O_3

34) Which of the following is not correct ? [EAMCET - 2005]

1) SiO_2 is used as acid flux

2) The distance between the layers in graphite is 3.35×10^{-8} cm

3) SiO_2 reacts with Na_2CO_3 and liberates CO

4) The hybridisation of C in graphite is sp^2

35) Formula for agate is **[MHT - 2005]**

1) Na_2SiO_3

2) $K_2O.SiO_2.Al_2O_3$

3) SiO_2

4) CaF_2

36) Which one of the following is used as an acidic flux in metallurgy ?
[EAMCET - 2004]

1) CaO

2) SiO_2

3) Na_2CO_3

4) SO_2

37) Which of the following is an ore of lead ? [BITSAT – 2004]

1) Galena

2) Calamine

3) Malachite

4) Dolomite

38) Sillicon is **[BITSAT – 2004]**

1) Semiconductor

2) Insulator

3) Conductor

4) None of these

39) Graphite is a soft solid lubricant extremely difficult to melt. The reason for this anomalous behaviour is that graphite ..

[AIEEE- 2003]

1) Is a non –crystalline substance

2) Is an allotropic form of diamond

3) Has molecules of variable molecular masses like polymers

4) Has carbon atoms arranged in large plates of rings of strongly bound carbon atoms with weak interplate bonds.

40) What is the number of free electrons contributed by each carbon atom in graphite ? [EAMCET – 2003]

1) Zero

2) 3

3) 2

4) 1 ✓

41) Carbon suboxide C_3O_2 has [EAMCET – 2003]

1) Linear structure

2) Bent structure

3) Trigonal planar structure

4) Distorted tetrahedral structure

42) Red lead is an example of **[AMU – 2003]**

1) Basic oxide

2) Super oxide

3) Mixed oxide

4) Amphoteric

43) When sand is heated with hydrofluric acid and a wet rod is brought in contact with vapours evolving a white deposit is due to ..

1) SiF_4

2) SiF_6

3) H_4SiO_4

4) None of these

44) Which one of the following is correct set for ' SiO_2' ?

[EAMCET – 2002]

1) Linear, Acidic

2) Linear, Basic

3) Tetrahedral, Acidic

4) Angular , Basic

45) The catenation tendency of C, Si and Ge is in the order Ge < Si <C. The Bond energies in (KJ Mol^{-1}) respectively are [EAMCET – 2001]

1) 167, 180, 348

2) 180, 167, 348

3) 348, 167, 180

4) 348, 180, 167

46) What is the C-C bond length (in A^0) in diamond [EAMCET – 2000]

1) 1.54

2) 3.34

3) 2.0

4) 5.2

47) Match the items in column I with its main use listed in Column II :

(J.M.O.L – 2016)

Column I	Column II
(A) Silica gel	(i) Transistor
(B) Silicon	(ii) Ion-exchanger
(C) Silicone	(iii) Drying agent
(D) Silicate	(iv) Sealant

1) (A) – (iii), (B) – (i), (C) – (iv), (D) – (ii)

2) (A) – (iv), (B) – (i), (C) – (ii), (D) – (iii)

3) (A) – (ii), (B) – (i), (C) – (iv), (D) – (iii)

4) (A) – (ii), (B) – (iv), (C) – (i), (D) – (iii)

48) Assertion : Among the carbon allotropes, diamond is an insulator; whereas, graphite is a good conductor of electricity.

Reason : Hybridization of carbon in diamond and graphite are sp^3 and sp^2 respectively. **(J.MO.L-2016)**

1) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion.

2) Bothe assertion and reason are correct, explanation for the assertion.

3) Both assertion and reason are incorrect.

4) Assertion is incorrect statement, but the reason is correct

49) Which of the following statements is not correct?

1) The tendency of exhibit +2 oxidation state for Ge, Sn and Pb is in the order Ge<Sn<Pb

2) Carbon and silicon mostly exhibit +4 oxidation state in their compounds

3) Lead in +4 oxidation state acts as an oxidizing agent

4) Tin in +4 oxidation state acts as a good reducing agent

50) The gas produced by the passage of air over hot coke is

(TS E – 2016)

1) Carbon monoxide

2) Carbon dioxide

3) Produce gas

4) Water gas

Solution :

Produce gas ($CO + N_2$)

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