APPENDIX - (X)
CONTENT OF BONDING AND MOLECULAR STRUCTURE

INTRODUCTION

In this chapter you will learn :

a) To write lewis structures of simple molecules.
b) Octet rule
c) Type of bonds :
   i. Ionic bond, Ionic Solids
   ii. Covalent Bond, Quantum theory for covalent bond, molecular solids, network solids.
   iii. Co-ordinate covalent bond
   iv. Metallic bond
   v. Van-Der-Waal's Bond
   vi. Hydrogen Bond

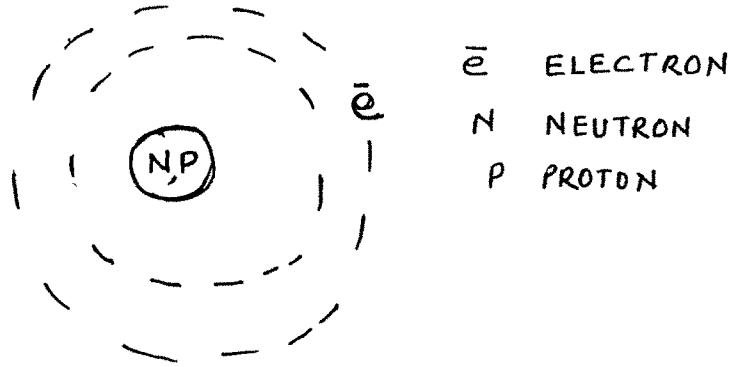
Following are a set of Questions to check your previous learning :

Select the correct choice

Q. 1 What are ATOMS ?

a. Constituent of compounds.
*b. Small indivisible particles are called ATOMS.
c. Unstable particles
d. atoms can have independent existence.

ANSKEY : Atoms are the smallest, indivisible particles, which are made up of electron, proton and neutron.



n,p - neutron & proton present in the nucleus

e are electron present in the orbit around the nucleus.

Q. 2 What are Molecules ?

a. are smallest particles of compound
b. are macromolecules.
*c. are smallest unit of substances that can exist independently.
d. Complex compounds.

ANS KEY : Molecules are the smallest unit of substances/compounds and can exists independently.

Molecules are formed from atoms of similar or of different kind.

Molecules are formed either by -

i. Sharing of electrons
ii. Transfer of electrons
iii. Donation of electron pair.

e.g.

i. Cl2 molecule Cl..Cl
ii. NaCl OR Na^+ Cl^-
iii. $NH_3 + H^+ \longrightarrow NH_4^+$

Q. 3 Why do ATOMS combine ?

a. atoms combine to get stability
*b. atoms combine to complete their octet
c. atoms combine to form molecules.
d. atoms combine to share electrons

ANS KEY : The explanation to the Question "why do atoms combine ?" is provided on the basis of - electronic configuration of noble gases.

The noble gases (Ne, Ar) have 8 electrons in their outermost shell. They do not have any tendency to take part in the reaction. Chemical inertness of noble gases was on the basis of octect of electrons in the their outer most shell.

Q. 4 What do we mean by octet rule ?

a. Getting stability in their compounds.
b. Getting converted into ions.
*c. Getting electronic configuration similar to that of noble gases/inert gases.
d. Removing the electrons from their valence shell.

ANS KEY : On the basis of observations `Lewis' put forward a generalization known as Octet Rule which states that "Atoms of various elements enter into chemical combination so as to attain the configuration of eight electrons in their outermost shell".

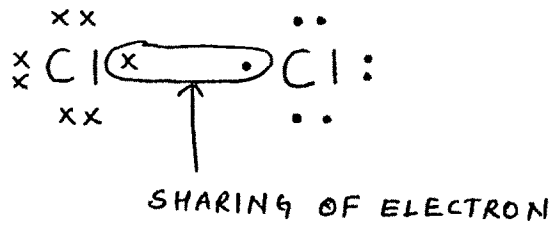
Q. 5 Why a definite number of atoms are used to constitute a particular molecule ? e.g. Hydrogen molecule is H2 and not H3 or H4.

a. To form stable molecule
*b. Depending upon valency of an element.
c. It's tendency to combine and form molecules.
d. As atoms can not have independent existence.

ANS KEY : Depending upon no. of electrons required for completing the octet or valency of an element. A definite no. of atoms combine to form a molecule.

e.g. in `Cl' atom at no. 17 electronic configuration (2,8,7)

It requires one electron to be shared with another atom of chlorine in order to complete it's octet.



Thus most of the substances exists in the form of molecules which are cluster of atoms of same or different kinds e.g.

There are other types of substances in which the constituents units are ions instead of atoms - e.g., sodium chloride

NaCl OR Na+Cl-

The attractive force which holds various constituents (atoms, ions etc.) together in different chemical species is called chemical bond.

The chemical bonds are classified into :

a. Ionic bond
b. Covalent bond
c. Co-ordinate covalent bond
d. Metallic bond
e. Hydrogen bond
f. Van-der waal's bond.

We will consider these bonds one by one after understanding lewis structure and octet rule.

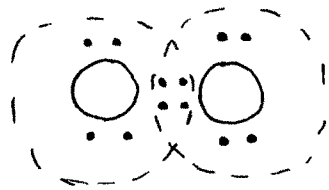
PART - I
OCTET RULE

The noble gases like neon, argon etc. have 8 electrons in their outer most shell, they do not have any tendency to take part in chemical combination.

The chemical inertness of noble gases was related to the presence of octet of electrons, because other elements which were chemically reactive had less then 8 electrons.

OCTET RULE

Having 8 electrons in the outer most valence shell.



- Represents electron

The Rule states that

"Atoms of various elements enter into chemical combination so as to attain the configuration of 8 electrons in their outer-most shell".

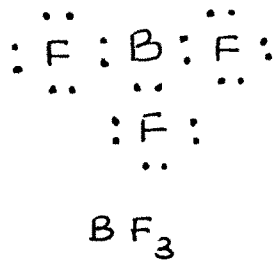
EXCEPTIONS TO THE OCTECT RULE

Eventhough octet rule is quite useful in explaining valencies at large. But there are exception to it : Such as

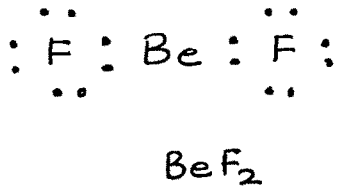
1. Hydrogen molecule has completely filled shell of helium.
   Here octet rule is not required to achieve a stable configuration.

H_2 MOLECULE

2. The elements of group I, II, III should not form covalent bond as they have less than 4e in their valence shell. But some of the elements form covalently bonded compounds, BF3 or BeF2.

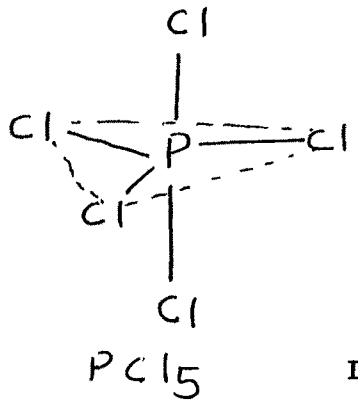


BF_3

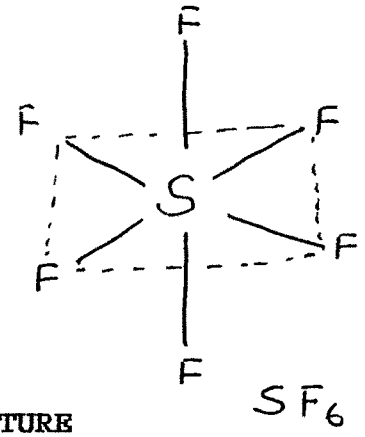


BeF_2

3. Octet rule is also not observed in the case of compounds like PF5, SF6



PCl_5

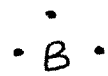


SF_6

LEWIS STRUCTURE

To represent the valence electrons of an atom lewis introduced "an electron dot symbol".

"The symbol of the element represents the nucleus as well as electrons of inner shell. The electrons of the outer most shell are represented by dot.



e.g. Li Be B

Lithium
At No.3

Beryllium
At No.4

Boron
At. No. "5"

Electron config.			
valency	$1S^2\ 2S^1$	$IS^2,\ 2S^2$	$IS^2\ 2S^2\ 2P^1$
	1	2	3

Now, Question is How to obtain valency of an element ?

	Carbon	C	O	Oxygen
At No.	6			8
E config.	$IS^2\ 2S^2\ 2P^2$			$IS^2\ 2S^2\ 2P^4$
Valency	8 - 4 = 4			8 - 6 = 2

The common valency of the atom is either equal to the number of dots or 8 minus No. of dots.

For Li, Na.

Valency = No. of Dots

For Nitrogen, phosphorous

Valency = 8 - (no. of dots)
= 8 - (5)
= 3

PART - 1

Note : * indicates correct answer

QUESTIONS :

Qus.1 Write the valency of the following elements.

Qus.2 According to the Lewis electron dot symbol. The valency of an atom obtained by ..

a. Counting only the no. of dots.
b. Substracting no. of dots from eight
c. None of above.
*d. Counting no. of dot's if ranging from 1 to 4 and if ranging from 5 to 7; then 8 minus no. of dots.

Qus.3 The octet rule states that all the elements tries to attain stability by having.....

a. 12 electrons in their outermost orbit.
b. 6 electrons in their outermost orbit.
*c. 8 electrons in their outermost orbit.
d. 10 electrons in their outermost orbit.

Qus.4 Which of the following molecules do not obey octet rule.

i. SO_2
*ii. SF_4
*iii. NO_2
iv. So_3
*v NO
*vi. BF_3
vii. PCl_3

Ans : SF_4, NO_2, NO and BF_3

PART - 2

TYPES OF BONDS

Ionic bond : It is formed by the transfer of electron.

From one atom to the another atom electron is transferred from a

Metal	to	Non-metal
Na	e	Cl
Na^+		Cl^-
Positive ion		Negative ion

Ions are held by electrostatic force of attraction.

Formation of sodium chloride
Na^+ Cl^-

Na : Sodium atom, Na (2,8,1) has one electron in its valence shell.

In order to acquire nearest inert gas configuration of Ne (2,8). It has to lose its valence electron.

Cl : Chlorine atom Cl (2,8,7) has "7" electrons in its valence shell.

It can acquire argon Ar (2,8,8) configuration.

By gaining one electron.

$$Na \longrightarrow Na^+ + e$$

Sodium atom it losses electron it is called "Electropositive atom", "+" sign is put before the symbol of atom.

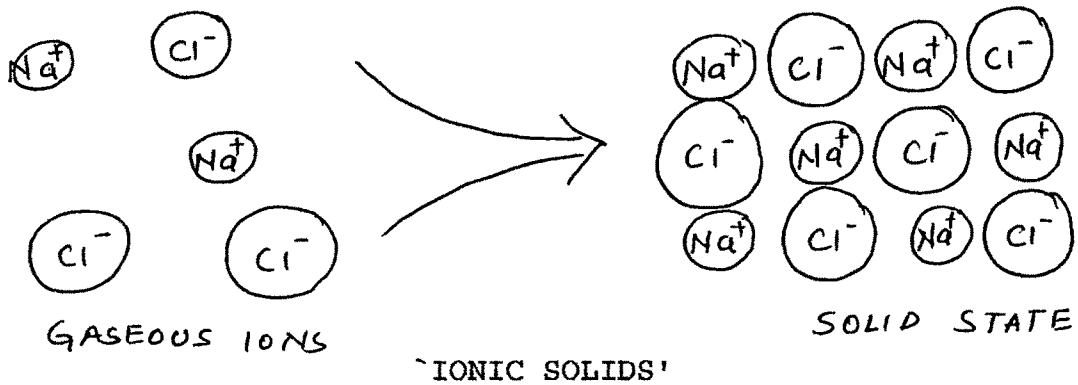
Na^+

Chlorine atom gains an electron hence called "Electronegative atom" `-' sign is put before the symbol of atom.

$$Cl + \bar{e} \xrightarrow{} Cl^-$$

Similarly by electron transfer `ionic bond' is formed between various electropositive and electronegative atom.

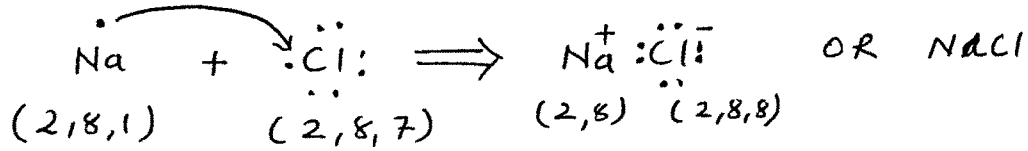
Example :



`IONIC SOLIDS'

Once `+' and `-' ions are formed -

These ions come close together and pack up three dimensionally in a definite pattern to form ionic crystal.



Packing of ions of opposite charges takes place as a result of attractive force and the energy released is known as "Lattice energy".

CHARACTERISTIC PROPERTIES OF IONIC SOLIDS

Ionic compounds exist in crystalline solids. Ions are arranged in a well-defined geometric pattern. Forming ionic crystal.

Ionic crystals have following properties :

1. Ionic solids are non-conductors of electricity. Because ions occupy fixed positions, and are not able to have free movement.

2. Ionic compounds are good conductors in fused state and in aqueous solution. As ions are free to move.
3. Ionic solids have high melting and boiling point. Because a strong electrostatic force attracts opposite charged ions.
4. Solubility : Ionic compounds are soluble in water and other polar solvents. It is because of strong electrostatic interaction between the ions and polar solvent.
5. Ionic reactions : Chemical reactions of ionic solids occur easily.

The pattern of arrangement of ions and crystal structure depends upon :

i. Size of ions and
ii. Magnitude of charge on the ions.

In ionic crystal, each ion is surrounded by maximum no. of opposite charged ions.

This number depends upon ratio of ionic radii of `+' & `-' ion i.e.,

$\frac{r^+}{r^-}$ = Coordination no. of metal ion.

Radius ratios in crystals

Radius Ratio $\frac{r^+}{r^-}$	Co-ordination No.	Structural Arrangement	Example
0.155-0.225	3	PLANE TRIANGULAR	BORON OXIDE
0.225-0.414	4	TETRAHEDRAL	ZINC SULFIDE
0.414-732	6	OCTAHEDRAL	SODIUM CHLORIDE
0.732-1.00	8	CUBIC	CALCIUM CHLORIDE

Examples :

In NaCl crystal $\frac{r^+}{r^-} = 0.525$

Na^+ ions are surrounded by six Cl^- ions.
Cl^- ions are surrounded by six Na^+ ions.

PART - II

Note : * indicate correct answer

Questions :

Qus.1 What is an ionic bond ?

a. a bond formed by special arrangement of electrons.
b. a bond formed by donating electron pairs.
c. a bond formed by sharing of electrons.
*d. a bond formed by transfer of electron.

Qus.2 An ionic bond is formed between -

a. metal and metal
b. non-metal and non-metal
*c. non-metal and metal.
d. transition metal and non-metal

Qus.3 From the following compound indicate which are formed by ionic bond.....

*a. MgBr
*b. CsCl
c. PCl_3
*d. CaCl2
e. BF3
d. CCl4

Qus.4 The definite arrangement of ions in the crystal structure is known as :

a. Ionic solid
b. Ionic crystal
c. Molecular solid
*d. Crystal lattice arrangement.

Qus.5 A definite no. of ions surrounding the opposite charged ions is known as .....

a. bonding no.
b. Crystal arrangement
c. atomic no.
*d. coordination no. of a crystal.

Qus.6 Ionic solids conduct electricity only in.....

a. Solid state
*b. Dissolved state/molten state.
c. gaseous state
d. free state.

Qus.7 Ionic solids are generally high melting solids due to

a. strong metallic bonding
b. molecular arrangement
c. vander waal's force of attraction.
*d. strong electrostatic attraction between oppositly charged ions.

PART - 3

COVALENT BOND

A covalent bond is formed by mutual sharing of electron.

It is a force which binds atoms of same or different elements by mutual sharing of electrons is called a covalent bond.

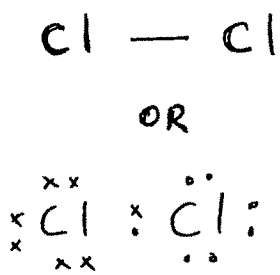
EXAMPLES :

1. Formation of Cl2 chlorine molecule.

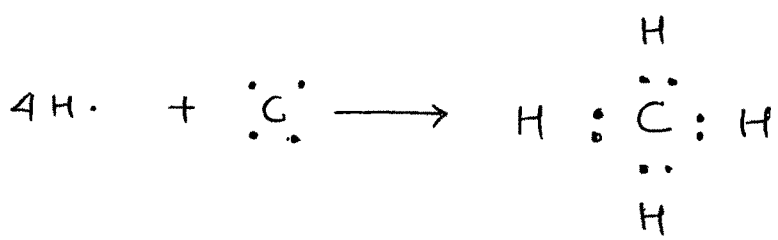
Each Cl atom, Cl (2,8,7) has seven electrons in it's valence shell. And need one electron to compete the octet.

Both Cl atoms contribute one electron each to share two electrons.

Bond is represented by dash line between the atoms.



2. Covalent bond can be between atoms of different elements :

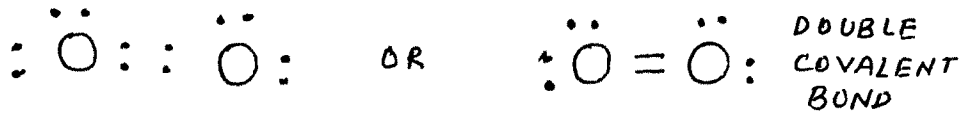


MULTIPLE COVALENT BONDS

When the atoms share

One electron pair	H..H OR H-H	single covalent bond
Two electron pair	O : : O	Double bond O = O
Three electron pair	N : : N N ≡ N	Triple bond

Double or triple bonds are called multiple covalent bond.



OXYGEN MOLECULE

NITROGEN MOLECULE

MODERN CONCEPT OF COVALENT BOND

Formation of bonds between the atoms occur as it is accompanied by decrease of energy.

For example let us study the formation of H2 molecule.

HYDROGEN MOLECULE

H2 (g) + 103.4 -----> H(g) + H(g)
1 mole KCal Atom of Hydrogen
H2 molecule

Hydrogen molecule breaks up into it's atoms by absorbing 103.4 Kcal. of energy.

Conversely, or If we consider reverse of the reaction it indicates that formation of hydrogen molecule is accompanied by release of 103.4 Kcal of energy.

$$H(g) + H(g) \text{ ----------> } H_2(g) + 103.4 \text{ Kcal.}$$

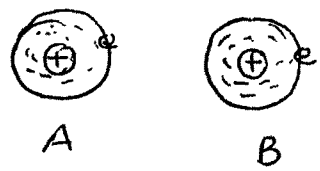
Thus, H2 molecule is lower in energy than its atoms.

Let us study how this lowering of energy occurs when hydrogen atoms combine.

SEPARATE ATOMS

Let us consider two hydrogen atoms A & B with one electron each eA and eB respectively.

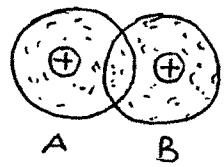
When HA, HB approach each other their orbitals interact.



APPROACHING ATOMS

(Interaction begins)

Electron of each atom come under the influence of other nucleus.



BONDED ATOMS (overlap of orbitals)

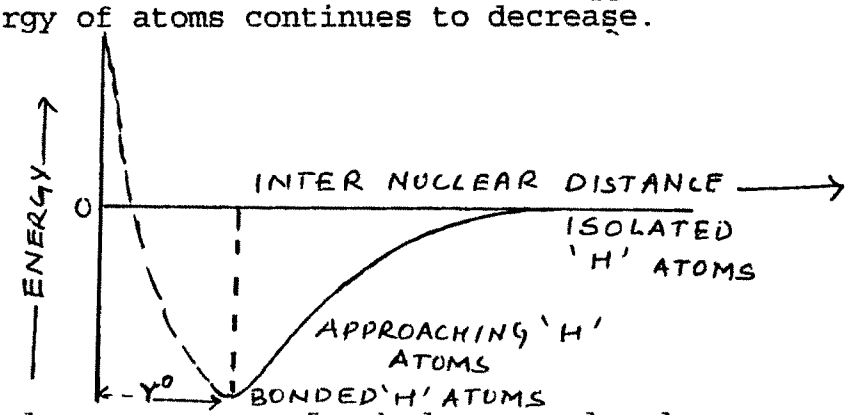
a. Attractive forces between - Two atoms - A and B
   1. electron eA and nucleus NB
   2. electron eB and nucleus HA

b. Repulsive forces between -
   1. electron eA and eB
   2. Nucleus HA and HB.

The attractive forces tend to bring two atoms close to each other.

Repulsive forces tend to push them apart.

Magnitude of attractive force is greater than repulsive force. Therefore the atoms approach each other and the energy of atoms continues to decrease.



Potential energy curve for hydrogen molecule

When distance between the atoms is r^0 (minimum), A stage is reached when the attractive and repulsive forces just balance each other.

Maximum lowering in energy takes place at critical distance r^0.

The critical distance r^0 corresponding to minimum energy is called bond length. The energy corresponding to the minimum in the curve is called bond energy.

If this much energy is supplied from outside, the bond will break. And molecule dissociates into atoms.

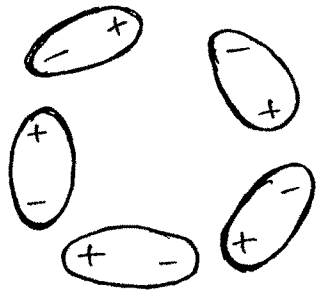
Thus, formation of molecule results into lowering of energy. Hence molecules are stable compared to isolated atoms.

MOLECULAR SOLIDS

In molecular solids atoms are bonded by covalent bond, molecules are held together by either 1. Dipole-Dipole interaction of 2. Van Der Waal's force.

1. DIPOLE-DIPOLE INTERACTIONS

These are forces among polar molecules. The positive end of molecule attracts the negative end of the molecule.



2. VAN-DER WAAL'S FORCES

These are forces among the non-polar molecules such as hydrogen (H2), oxygen (O2) etc. in solid in liquid state or gaseous state.

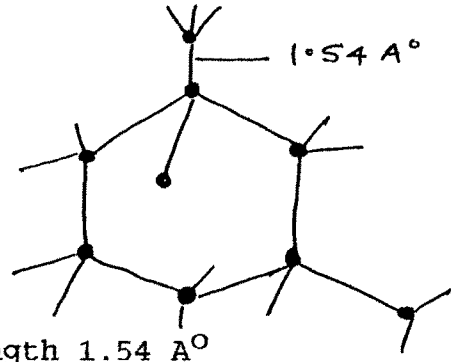
NETWORK SOLIDS

These solids have crystal made up of giant network or atoms linked to each other by covalent bonds. Examples : Diamond, graphite, silicon carbide.

DIAMOND

`C' atom is $SP^3$ hybridized. Each `C' is linked tetrahedrally to other four `C' atoms.

STRUCTURE OF DIAMOND



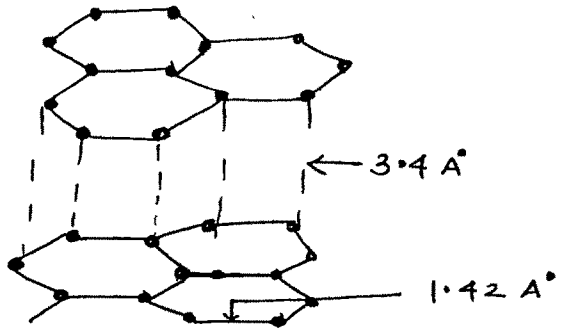
C-C bond length 1.54 A^O
Bond angle 109^O 28' density 3.51 gm/cm^3
Melting point 3843 OK.

PROPERTIES OF DIAMOND

i. It is poor conductor of electricity as all electrons are involved in C-C bond.
ii. It is very hard. As this structure is repeated in three dimension.

STRUCTURE OF GRAPHITE

Each `C' atom is SP^2 hybridised and is linked to three other carbon atoms in the same plane. To form hexagonal rings. These rings constitute layers of atoms.



PROPERTIES OF GRAPHITE

i. C-C bond length 1.42A^O
   - Distance between two
ii. Layers ----------> 3.4 A^O
iii. Bond angle 120^O
iv. Density 2.26 gm/cm^3
v. Graphite is soft
vi. Graphite is good conductor of electricity as delocalized electron is available per atom to conduct electricity.

PART - 3

Note : * indicates correct answer

QUESTIONS :

Qus.1 Covalent bond is formed by

a. Transfer of electron pair.
b. Molecules of similar type.
*c. Sharing of electron pair between atoms.
d. Metals only.

Qus.2 Covalent bond is formed usually between the atoms

a. having very high difference in the electronegativity.
*b. which are non-metallic in nature.
c. of similar type.
d. metal and non-metal.

Qus.3 Lewis theory of covalent bond had defects as it could not explain properly about.....

a. Property of molecules.
b. Bonding parameters.
*c. Shapes of molecules and bond polarity.
d. Types of molecules formed.

Qus.4 When a covalent bond is formed, the energy of the atoms,

a. increases
*b. decreases
c. does not change
d. sometimes increases and sometimes decreases.

Qus.5 According the principle of overlapping of orbitals....

a. Orbitals of different atoms overlap with spin of electron in the same direction.
*b. orbitals overlap with spin in opposite direction.
c. orbitals overlap completely.
d. orbitals overlap irrespective of spin direction.

Qus.6 The strength of Vander-waals force of attraction depends upon -

a. intermolecular distance between the two molecules.
b. Shape of the molecule.
c. No. of electrons in the molecule
*d. All of the above

Qus.7 Melting point of sulfur is more than that of phosphorous.

a. Sulfur exists as S8 and phosphorous exists as P4 molecule.
b. No. of electrons in sulfur molecule is greater than the no. of electrons in the phosphorous molecule.
c. intermolecular distance in sulfur is less than in phosphorous.
*d. All above reasons accounts for high melting point of sulfur.

Qus.8 Covalent network solid are.....

*a. Covalent compounds with net working of covalent bond in their crystal lattice.
b. Compounds with network system of van-der-waal's bond.
c. Compounds with ionic bond throughout crystal lattice.
d. None of the above.

PART 3A

CO-ORDINATE COVALENT BOND (OR) DATIVE BOND

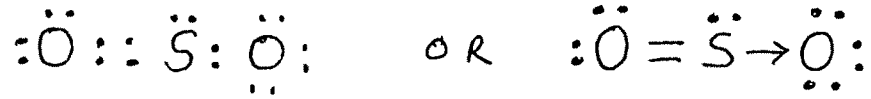
It is formed by sharing of electrons between the two atoms. But the shared pair of electron is contributed by one of the two atoms, the other atom simply participates in sharing.

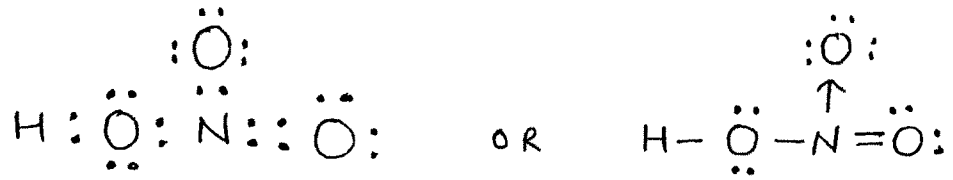
- Atom which donates a pair of electron is called DONOR
- Atom which accepts a pair of electron is called ACCEPTOR.

e.g.

1. In the formation of ozone molecule.
   Oxygen molecule shares a lone paid of electron with another oxygen atom.

2. SO_2 molecule





3. HNO_3 molecule

ORBITAL CONCEPT OF CO-ORDINATE COVALENT BOND

According to orbital theory, a coordinate bond is formed when an orbital of the atom having a lone pair of electron overlaps with the empty orbital of the other atom.

In the formation of ammonium ion (NH_4)

The central nitrogen atom of ammonia molecule has one orbital containing a lone pair of electron while other three are bond pair electrons.

H^+ ion has empty 1s orbital.

Empty 1s orbital of hydrogen ion overlaps with the orbital of nitrogen carrying lone paid or electron.

PART 3(A)

Note : * indicates correct answer

QUESTIONS :

Qus.1 For the formation of coordinate covalent bond the primary requirements are.....

a. Presence of Lewis base & donor atom.
b. Presence of Lewis acid & acceptor atom.
*c. Presence of donor & acceptor atom or molecules.
d. Presence of atoms of similar kind.

Qus.2 From the following compounds indicate which compounds can form coordinate covalent bond by donating electron pairs.

*a. CO Carbon monoxide.
b. H+ (proton)
*c. NO2 (Nitrogen dioxide)
*d. H2O (Water)
e. Cu (Copper)
f. He (Helium)

PART - 4

METALLIC BOND AND METALLIC SOLIDS

METALS HAVE CHARACTERISTIC PROPERTIES SUCH AS -

* Luster
* High electrical and thermal conductivity.
* Malleability and ductility
* High tensile strength.

The attractive force which binds various metal atoms together is called metallic bond.

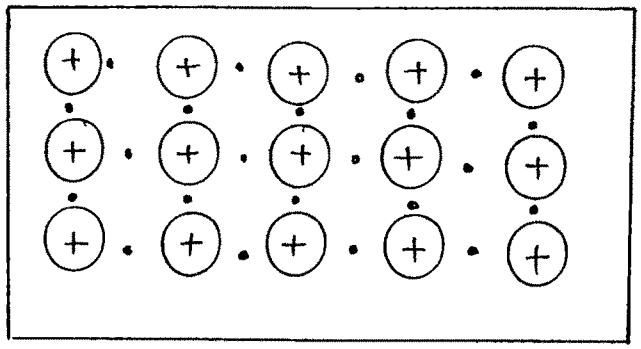
In order to understand the nature of bonding in metals. Let us look into general atomic properties of metals :

* Low ionization energies
* Low electron affinities
* Large number of vacant orbitals in the valence shell
* Less no. of valence electrons.

Based on all the properties possessed by the metals, bonding in the metals is explained as follows -

i. A metal atom is supposed to consist of two parts, valence electrons and remaining part (nucleus and inner shells) which is called kernel.

ii. The metallic crystal consists of closely packed metal atoms occupying fixed positions called lattice sites while space between the kernels is occupied by valence electrons.



Due to smaller ionization energy valence electrons of metal atoms are not held tightly, therefore, they can leave valence shell of their atoms to the valence shell of other atoms.

Valence shell electrons are not localized and are in a state of motion.

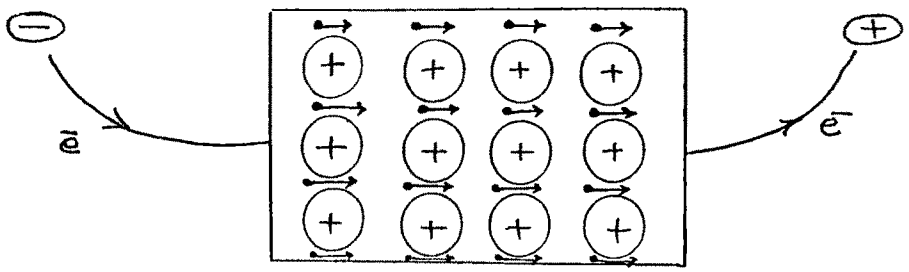
The simultaneous force of attraction between the mobile electrons and the positive kernel is responsible for holding the metal atoms together and is known as Metallic Bond.

PROPERTIES POSSESSED BY METALS :

The presence of free electrons explains most of the characteristics properties of metals :

1. **METALLIC LUSTER** : When light falls on the surface of the metal, the free electrons absorb the photons of light and are set into vibrations. These vibration electrons immediately emit energy and become a source of light. Thus, incident light appears to be reflected from the surface of the metal.

2. **ELECTRICAL CONDUCTIVITY** : When a potential difference is applied across the metallic strip, free electrons start-moving towards positive terminal. Similarly electrons from the negative terminal move into the metallic crystal.



Electrical conductivity of Metals

3. **THERMAL CONDUCTIVITY** : Conduction of heat through metals can also be explained on the basis of electron gas model.

On heating metal kinetic energy of electrons in that region increases. These energetic electrons move to the cooler part and transfer their kinetic energy by means of collision with other electrons. In this way heat travels from hotter to cooler part of the metal.

4. **MALLEABILITY AND DUCTILITY** : By these properties metals can be drawn into thin sheets and wires.

This property of metals is due to the non-directional character of the bond. Whenever stress is applied onto metal, metallic kernels shifts without disturbing the crystal.

5. **HIGH TENSILE STRENGTH** : It is the property of metals by which they can be stretched without breaking. The high tensile strength is due to strong electrostatic force of attraction. Between positive kernels and mobile valence electrons.

PART - 4

Note : * indicates correct answer

Questions :

Qus.1 Metals are good conductor of electricity because of...

a. Presence of atoms
b. Presence of ions.
*c. availability of free electrons.
d. presence of atomic kernels

Qus.2 Metals are bonded together by metallic bonding due to..

a. The presence of free ions.
*b. The presence of one, two or three valence electrons in their valence shell.
c. The presence free metal ions.
d. The presence of empty valence shells.

Qus.3 Metals possess the properties like

i. Good conductors of heat & electricity.
ii. Metals have luster.
iii. Metals are ductile & Malleable.
iv. Metals have high tensile strength due to.....

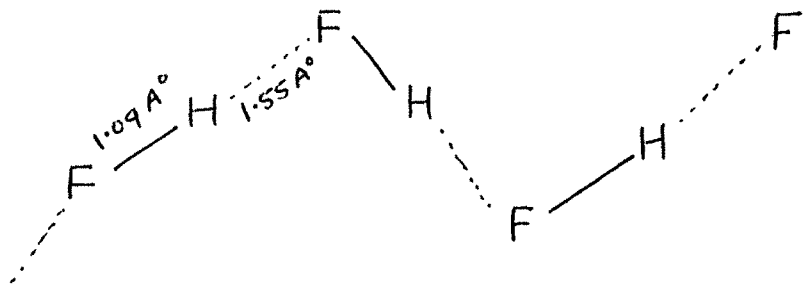
a. Their low value of electron affinity.
b. Their tendency to lose electrons.
c. Vacant valance shell.
*d. Metallic bonding.

PART - 5

HYDROGEN BOND

Hydrogen bond comes into existence as a result of dipole-dipole interactions between the molecules. Hence, following conditions are required for effective hydrogen bonding.

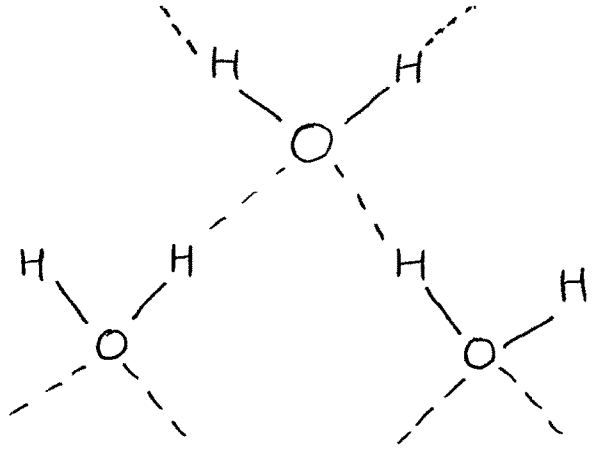
(1) Hydrogen should be bonded to a highly electronegative atom such as F,O, OR N. Larger the electronegativity of the atom greater is the strength or hydrogen bond.



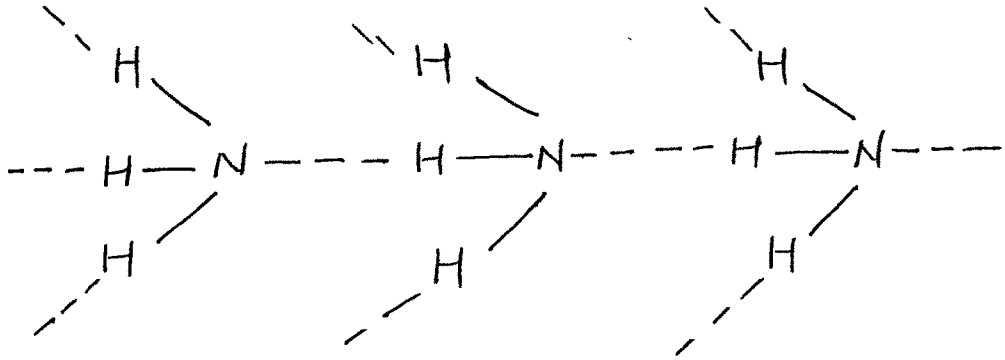
In HF hydrogen is bonded with highly electronegative atom fluorine. Due to which covalent H-F bond becomes polar. It has been found in the solid state HF consist of long Zig-Zag chains HF molecules associated By-H-bond.

(2) WATER (H_2O)

Hydrogen is bonded with electronegative oxygen atom. Hence O-H covalent bond becomes polar bond.



(3) AMMONIA IN AMMONIA MOLECULE NH_3



Nitrogen atom is bonded with three hydrogen atoms. Nitrogen acquires negative charge and Hydrogen acquires positive charge.

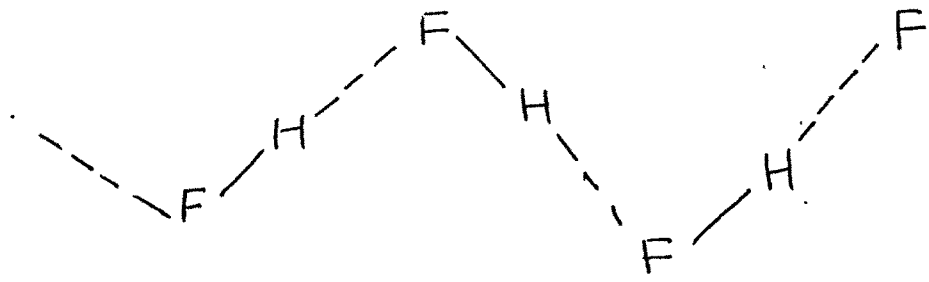
INFLUENCE OF HYDROGEN BONDING ON THE PROPERTIES :

Hydrogen bond has a marked influence on the properties of various substances as discussed below :

(a) **Association :**

Hydrogen bond link up molecules of the same substances to form large aggregates. This is called association of molecules.

e.g. HF molecules are associated with one another by Hydrogen-bond.



(b) **Melting point and Boiling Point :**

The compounds whose molecules are associated with one another by H-bonds have abnormally high melting and boiling point.

Reason : It is due to the fact that a large amount of energy is needed to overcome intermolecular bonds and to separate the molecules.

Table of M.P. and B.P. of Hydrides

	Group 14			Group 15	
	M.P.	B.P.		M.P.	B.P.
CH4	89.0	111.5	NH3	195.0	239.6
SiH4	88.0	161.2	PH3	138.0	185.0
GeH4	108.0	183.0	AsH3	159.0	218.0
SnH4	123.0	221.0	SbH3	184.0	256.0

	Group 16			Group 17	
	M.P.	B.P.		M.P.	B.P.
H2O	273.0	373.0	HF	180.7	292.4
H2S	190.0	211.2	HCl	161.0	189.4
H2Se	209.0	231.0	HBr	184.5	206.0
H2Te	222.0	271.0	HI	222.2	237.0

From the values of boiling point, it is clear that hydrides of 1st member of each group namely.

NH3, H2O, HF have high boiling points.

This indicates that in these hydrides attractive forces are stronger than the van-der-waal's forces.

The unexpected behaviour of such compounds can be explained on the basis of the concept of the Hydrogen bonding.

Reason : When H-atom is bonded to a highly electronegative atom by a covalent bond, the bond pair of electrons is displaced towards the electronegative atom. And thus the bond becomes polar with + & - End.

As a result the +ve end of the molecule is attracted by the -ve end of another molecule. This electrostatic attraction between H and Z electronegative atom is called H-bond. It is represented by (...) dotted line.