CHEMICAL BONDING

CAUSE AND MODES OF CHEMICAL COMBINATION

Atoms of different elements *excepting* noble gases donot have complete octet so they combine with other atoms to form chemical bond. *The force which holds the atoms or ions together within the molecule is called a* ***chemical bond*** and the process of their combination is called ***Chemical Bonding***.

Chemical bonding depends on the valency of atoms. Valency was termed as the number of chemical bonds formed by an atom in a molecule or number of electrons present in outermost shell *i.e.*, valence electrons. Valence electrons actually involved in bond formation are called bonding electrons. The remaining valence electrons still available for bond formation are referred to as non-bonding electrons.

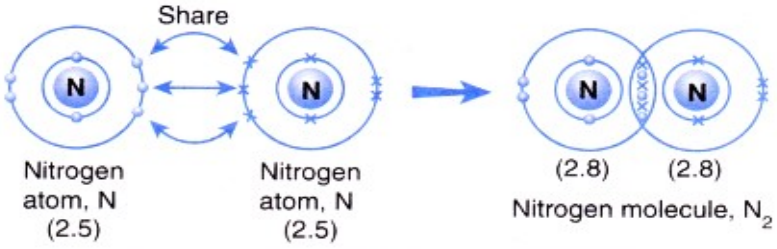


Figure *Formation of a nitrogen molecule, N_2*

Chemical combination takes place due to following reasons.

(1) *Chemical bonding takes place to acquire a state of minimum energy and maximum stability.*

(2) *By formation of chemical bond, atoms convert into molecule to acquire stable configuration of the nearest noble gas.*

Modes : Chemical bonding can occur in the following manner.

Transfer of electrons from one atom to another → Ionic bond
Mutual sharing of electrons between the atoms → Covalent bond
Mutual sharing of electrons provided entirely by one of the atoms → Co-ordination bond

Electrovalent bond :

When *a bond is formed by complete transfer of electrons from one atom to another* so as to complete their outermost orbits by acquiring 8 electrons (*i.e.,* octet) or 2 electrons (*i.e.,* duplet) in case of hydrogen, helium etc. and hence acquire the stable nearest noble gas configuration, the bond formed is called **ionic bond, electrovalent bond or polar bond**. Compounds containing ionic bond are called **ionic, electrovalent** or **polar compounds.**

Example : $Na + Cl \rightarrow [Na]^+ [Cl]^-$ or Na^+Cl^-

Some other examples are: $MgCl_2$, $CaCl_2$, MgO, Na_2S, CaH_2, AlF_3, NaH, KH, K_2O, KI, $RbCl$, $NaBr$, CaH_2 etc.

(1) **Conditions for formation of electrovalent bond**

(A) Factors favourable for cation formation :

i) **Low ionisation potential :** Atom having very low ionisation potential forms the cation very easily. Potassium (IP=495.57 kJ/mole) forms the cation more readily than sodium(IP=519.82 kJ/mole)

ii) **Low charge on the ion** : Formation of cation carrying less positive charge is easy. ($Al^{+3} < Mg^{+2} < Na^{+}$)

iii) **Large atomic size :** Atoms with large atomic size form cations easily $Cs^{+} > Rb^{+} > K^{+} > Na^{+} > Li^{+}$

iv) **Formation of cation with Inertgas configuration:** Formation of cation having inert gas configuration is very easy.

Example : Of the two cations Zn^{+2}(2, 8, 18) and Ca^{+2}(2, 8, 8), Ca^{+2} is more readily formed and it is more stable than $Zn^{+2}$and gives compounds with more ionic character.

(B) Factors favorable for anion formation :

i) **High Electronegativity and Electron affinity :** Atom having very high electron affinity (or) electro negativity forms anion very easily. F > O > N

ii) **Small atomic size** : Small non metal atom forms anion very easily.

$F^{-} > Cl^{-} > Br^{-} > I^{-}$

iii) **Low charge on the ion :** Formation of anion carrying less negative charge is easy.

$F^{-} > O^{-2} > N^{-3}$

iv) **Formation of anion having inert gas configuration is very easy**

Electro negativity of		Changes occuring in the valence electrons	Nature of the bond formed
Element A	Element B		
Low	High	Transfer of $\bar{e}$	Ionic bond
High	High	Sharing of $\bar{e}$	Covalent bond
Low	Low	Sea of $\bar{e}$ molecular orbital bond	Metallic bond

→Among NaCl, KCl, RbCl and CsCl , CsCl is readily formed.

→Among NaF, NaCl and NaBr, NaF is readily formed.

→Among NaF, CsF, MgO and CaO, CsF is readily formed.

→ ***No Bond is 100% ionic in nature. It has some percentage of covalent character which is explained on the basis of Fajan's rule.***

v) **Polarising Power:** The ability of cation to polarise the near by anion is called polarising power or polarsing ability.

vi) **Polarisability:** The tendency of anion to get distorted or polarised by the cation is called its polarisability

vii) **Polarising relates to cation:**

Polarising power $\propto$ charge on cation

$$\propto \frac{1}{\text{size}}$$

viii) **Polarisability relates to anion**

Polarisability $\propto$ charge

$\propto$ size

ix) Polarising power increases covalent character increases

Example: Incase of $NaCl, MgCl_2, AlCl_3$ the polarisation increases, $Na^+ < Mg^{+2} < Al^{+3}$

Incase of AlF_3, $AlCl_3$, $AlBr_3$, AlI_3, the polarisability of halide ions increases as

$$F^- < Cl^- < Br^- < I^-$$

x) Covalent character increases with increase in size of halide ion

xi) Cation with 18electrons in outer most shell bring greater polarisation of the anion than those with inert gas configuration.

Example : $CuCl$ is more covalent when compared to $NaCl$

Points to Remember

→ On moving down a group the polarising power of cation decreases

→ In periods polarising power increases from left to right

→ Polarisability of anion decreases from left to right

→ Polarisability of anion increases from top to bottom

→ Increase of polarisation brings more covalent character in an ionic com pound

→ Increase in covalent character is indicated by the decrease in melting point of the ionic compound

→ Polarisation increases covalent character increases melting point decreases

Lattice Enthalpy

The amount of energy released when the required number of oppositely charged gaseous ions present at infinite distances come close and form one mole of ionic crystalline solid is known as the lattice energy of the compound.

→ Lattice energy is directly proportional to the product of Z^+ and Z^- and inversely proportional to the sum of the radii of cation and anion.

Lattice energy $\alpha \frac{Z^+Z^-}{\left(r_c^+ + r_a^-\right)}$ where Z^+ is charge on cation and Z^- is charge on anion.

Determination of lattice energy (Born Haber cycle)

When a chemical bond is formed between two atoms (or ions), the potential energy of the system constituting the two atoms or ions decreases. If there is no fall in potential energy of the system, no bonding is possible, the energy changes involved in the formation of ionic compounds from their constituent elements can be studied with the help of a thermochemical cycle called **Born Haber cycle.**

Example : The formation of 1 mole of $NaCl$ from sodium and chlorine involves following steps :

Step I : Conversion of metallic sodium into gaseous sodium atoms

$$\underset{1\ mole}{Na(s)} + S \rightarrow Na(g),$$

where *S*= sublimation energy *i.e.*, the energy required for the conversion of one mole of metallic sodium into gaseous sodium atoms.

Step II : Dissociation of chlorine molecules into chlorine atoms

$$Cl_2(g) + D \rightarrow 2Cl(g),$$

where *D* = Dissociation energy of Cl_2 so the energy required for the formation of one mole of gaseous chlorine atoms $= D/2$.

Step III: Conversion of gaseous sodium atoms into sodium ions

$$\underset{1\ mole}{Na(g)} + IE \rightarrow Na^+(g) + e^-,$$

where *IE* = Ionisation energy of sodium.

Step IV: Conversion of gaseous chlorine atoms into chloride ions

$$\underset{1\ mole}{Cl(g)} + e^- \rightarrow Cl^-(g) + EA,$$

where *EA* = Electron affinity of chlorine.

Step V : Combination of gaseous sodium and chloride ions to form solid sodium chloride crystal.

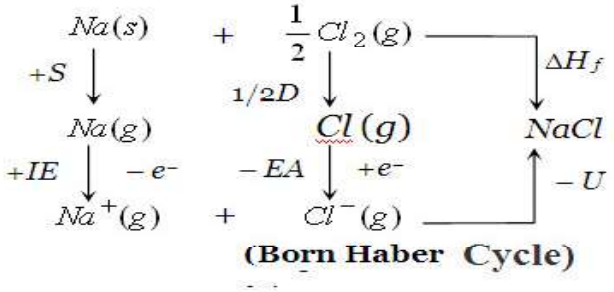
$$Na^+(g) + Cl^-(g) \rightarrow \underset{1\ mole}{NaCl(s)} + U,$$

where $U =$ lattice energy of $NaCl$

The overall change may be represented as :

$$Na(s) + \frac{1}{2}Cl_2(g) \rightarrow NaCl(s),\ \Delta H_f,$$

where ΔH_f is the heat of formation for 1 mole of $NaCl(s)$.



(Born Haber Cycle)

According to Hess's law of constant heat summation, heat of formation of one mole of *NaCl* should be same whether it takes place directly in one step or through a number of steps. Thus,

$$\Delta H_f = S + \frac{1}{2}D + IE + EA + U$$

2) **Types of ions**

The following types of ions are encountered :

(i) *Ions with inert gas configuration* : The atoms of the representative elements of group I, II and III by complete loss of their valency electrons and the elements of group V, VI, and VII by gaining 3,2 and 1 electrons respectively form ions either with ns^2 configura-

tion or ns^2p^6 configuration.

(a) *Ions with* $1s^2$ *(He) configuration* : H^-, Li^+, Be^{2+} etc. The formation of Li^+ and Be^{2+} is difficult due to their small size and high ionisation *potential.*

(b) *Ions with* ns^2p^6 *configuration* : More than three electrons are hardly lost or gained in the ion formation

Cations : Na^+, Ca^{2+}, Al^{3+} **etc.**

Anions : Cl^-, O^{2-}, N^{3-}, **etc.**

(ii) ***Ions with pseudo inert gas configuration*** **:** The Zn^{2+} ; ion is formed when zinc atom loses its outer 4s electrons. The outer shell configuration of Zn^{2+} ions is $3s^2 3p^6 3d^{10}$. The $ns^2np^6nd^{10}$ outer shell configuration is often called pseudo noble gas configuration which is considered as stable one.

Examples: $Zn^{2+}, Cd^{2+}, Hg^{2+}, Cu^+ Ag^+, Au^+, Ga^{3+}$ etc

(iii) ***Exceptional configurations*** **:** Many *d*- and *f* block elements produce ions with configurations different than the above two. Ions like Fe^{3+}, Mn^{2+}, etc., attain a stable configuration half filled *d*- orbitals

Fe^{3+} $3s^2 3p^6 3d^5$; Mn^{2+} $3s^2 3p^6 3d^5$

Examples of other configurations are many.

Ti^{2+} $(3s^2 3p^6 3d^2)$; V^{2+} $(3s^2 3p^6 3d^3)$

Cr^{2+} $(3s^2 3p^6 3d^4)$; Fe^{2+} $(3s^2 3p^6 3d^6)$

However, such ions are comparatively less stable

(iv) ***Ions with*** ns^2 ***configuration*** **:** Heavier members of groups III, IV and V lose *p*-electrons only to form ions with ns^2 configuration. $Tl^+, Sn^{2+}, Pb^{2+}, Bi^{3+}$ are the examples of this type. These are stable ions.

(**v**) ***Polyatomic ions*** **:** The ions which are composed of more than one atom are called polyatomic ions. These ions move as such in chemical reactions. Some common polyatomic ions are

NH_4^+ (Ammonium); NO_3^- (Nitrate)

PO_4^{3-} (phosphate); SO_4^{2-} (Sulphate)

CO_3^{2-} (Carbonate) ; SO_3^{2-} (Sulphite), etc.

(vi) ***Polyhalide ions*** **:** Halogens or interhalogens combine with halide ions to form polyhalide ions. I_3^-, ICl_4^-, ICl_2^- etc. Fluorine due to highest electronegativity and absence of d-oribitals does not form polyhalide ions.

The atoms within the polyatomic ions are held to each other by covalent bonds.

The electro valencies of an ion (any type) is equal to the number of charges present on it.

(3) **Method of writing formula of an ionic compound**

In order to write the formula of an ionic compound which is made up of two ions (simple or polyatomic) having electrovalencies x and y respectively, the following points are followed

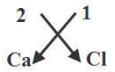
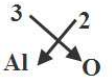
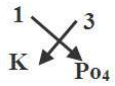
(i) Write the symbols of the ions side by side in such a way that positive ion is at the left and negative ion at the right as *AB*.

(ii) Write their electrovalencies in figures on the top of each symbol as $A^x B^y$

(iii) Divide their valencies by H.C.F

(iv) Now apply criss cross rule as $\frac{x}{A} \times \frac{y}{B}$, i.e., formula $A_y B_x$

Examples :

Name of compound	**Exchange of valencies**	**Formula**
Calcium chloride		$CaCl_2$
Aluminium oxide		Al_2O_3
Potassium phosphate		K_3Po_4
Magnesium nitride		Mg_3N_2

4) **Difference between atoms and ions**

The following are the points of difference between atoms and ions.

Atoms	**Ions**
Atoms are perfectly neutral in ions nature, i.e., number of protons equal to number of electrons. *Na* (protons 11, of electrons 11), *Cl* (Protons – 17, electrons –17) electrons.	Ions are charged particles, cat are positively charged, i.e., number of protons more than the number electrons. Anions are negatively charged, i.e., number of protons less than the number of Na^+ (protons 11, electrons 10), Cl^- (protons 17, electrons 18)
.Except noble gases, atoms have less than 8 electrons in the outermost orbit *Na* 2,8,1; *Ca* 2,8,8,2 *Cl* 2,8,7; S 2,8,6	Ions have generally 8 electrons in the outermost orbit, i.e., ns^2np^6 configuration. Ca^{2+} 2,8,8 Na^+ 2,8; Cl^- 2,8,8
Chemical activity is due to loss or gain or sharing of electrons as to acquire charge noble gas configuration.	The chemical activity is due to the on the ion. Oppositely charged ions are held together by electrostatic forces

5) **Characteristics of ionic compounds**

(i) *Physical state* : Electrovalent compounds are generally crystalline is nature. The constituent ions are arranged in a regular way in their lattice. These are hard due to strong forces of attraction between oppositely charged ions which keep them in their fixed positions.

(ii) *Melting and boiling points* : Ionic compounds possess high melting and boiling points. This is because ions are tightly held together by strong electrostatic forces of attraction and hence a huge amount of energy is required to break the crystal lattice. For

example order of melting and boiling points in halides of sodium and oxides of IInd group elements is as,

$$NaF > NaCl > NaBr > NaI, \quad MgO > CaO > BaO$$

(iii) *Hard and brittle* : Electrovalent compounds are hard in nature. The hardness is due to strong forces of attraction between oppositely charged ion which keep them in their alloted positions. The brittleness of the crystals is due to movement of a layer of a crystal on the other layer by application of external force when like ions come infront of each other. The forces of repulsion come into play. The breaking of crystal occurs on account of these forces or repulsion.

(iv) *Electrical conductivity* : Electrovalent solids donot conduct electricity. This is because the ions remain intact occupying fixed positions in the crystal lattice. When ionic compounds are melted or dissolved in a polar solvent, the ions become free to move. They are attracted towards the respective electrode and act as current carriers. Thus, electrovalent compounds in the molten state or in solution conduct electricity.

(v) *Solubility* : Electrovalent compounds are fairly soluble in polar solvents and insoluble in non-polar solvents. The polar solvents have high values of dielectric constants. Water is one of the best polar solvents as it has a high value of **dielectric constant**. *The **dielectric constant** of a solvent is defined as its capacity to weaken the force of attraction between the electrical charges immersed in that solvent. In solvent like water, the electrostate force of attraction between the ions decreases. As a result there ions get separated and finally solvated*.

The values of dielectric constants of some of the compounds are given as

Compound	Water	Methyl Alc	Ethyl Alc.	Acetone	Ether
Dielectric constant	81	35	27	21	4.1

Capacity to dissolve electrovalent compounds decreases

Lattice energy and solvation energy also explains the solubility of electrovalent compounds. ***These compounds dissolve in such a solvent of which the value of solvation energy is higher than the lattice energy of the compound***. The value of solvation energy depends on the relative size of the ions. Smaller the ion more of solvation, hence higher the solvation energy.

***Note*:** Some ionic compounds *Example :* $BaSO_4, PbSO_4, AgCl, AgBr, AgI, Ag_2CrO_4$ etc. are sparingly soluble in water because in all such cases higher values of lattice energy predominates over solvation energy.

(vi) *Space isomerism* :The electrovalent bonds are non-rigid and non-directional. Thus these compound do not show space isomerism e.g. geometrical or optical isomerism.

(vii) *Ionic reactions* : Electrovalent compounds furnish ions in solution. *The chemical reaction of these compounds are ionic reactions, which are fast. Ionic bonds are more common in inorganic compounds*.

$$K^+Cl^- + \overset{+}{A}g\ \overset{-}{N}O_3 \longrightarrow \underset{\text{(Precipitat e)}}{\overset{+}{A}g\ \overset{-}{C}l} \downarrow + \overset{+}{K}\ \overset{-}{N}O_3$$

(viii) *Isomorphism* : Electrovalent compounds show isomorphism. Compound having same electronic structures are isomorphous to each other.

(ix) *Electrovalency and Variable electrovalency* : *The capacity of an element to form electro-valent or ionic bond is called its electro-valency* **or** *the number of electrons lost*

or gained by the atom to form ionic compound is known as its electro-valency.

Certain metallic element lose different number of electrons under different conditions, thereby showing variable electrovalency. The following are the reasons:

(a) *Unstability of core* : *The residue configuration left after the loss of valency electrons is called kernel or core*. In the case of the atoms of transition elements, ions formed after the loss of valency electrons do not possess a stable core as the configuration of outermost shell is not ns^2np^6 but $ns^2np^6d^{1\text{ to }10}$. The outer shell lose one or more electrons giving rise to metal ions of higher valencies.

Example : $Fe^{2+} = 3s^2\,3p^6\,3d^6,4s^0$ (not stable)

$Fe^{3+} = 3s^2\,3p^6\,3d^5,4s^0$ (stable)

(b) *Inert pair effect* **:** Some of heavier representative elements of third, fourth and fifth groups having configuration of outermost shell $ns^2\ np^1$, $ns^2\ np^2$ and $ns^2\ np^3$ show valencies with a difference of 2, *i.e*., (1 : 3) (2 : 4) (3 : 5) respectively. In the case of lower valencies, only the electrons present in *p*–subshell are lost and ns^2 electrons remain intact. The reluctance of *s*-electron pair to take part in bond formation is known as the inert pair effect.

TEACHING TASK

I. MCQ's with single correct answer

1. The number of valency electrons and the valency with respect to hydrogen are equal for
   A) Sulphur B)Silicon C) Phosphorus D) Chlorine
2. The element having highest valency with respect to oxygen is
   A) Sodium B). Aluminium C) Chlorine D) Sulphur
3. Metal 'M' forms a peroxide of the type MO_2. Valency of the metal with respect to oxygen
   A) 0 B) 1 C) 2 D) 4
4. An element A is tetravalent and another element B is divalent. The formula of the compound formed by the combination of these elements is
   A) A_2B B) A B C) AB_2 D) A_2B_3
5. An atom A has 2K, 8L and 3M electrons. Another atom B has 2 K and 6 L electrons. The formula of the compound formed between A and B is
   A) A B B) A_2B_3 C) A_3B_2 D) AB_2
6. Two elements X and Y the have following electron configurations, X= $1s^2,2s^2\ 2p^6,\ 3s^2\ 3p^6,\ 4s^2$ and Y= $1s^2,2s^2\ 2p^6,\ 3s^2\ 3p^5$. The formula of the compound formed by the combination of X and Y is
   A) XY_2 B) X_5Y_2 C) X_2Y_5 D)XY_5
7. Which of the following exhibits variable valency
   A) Na B) H C)Al D) S
8. In a short period, as the atomic number increases, the valency of elements with respect to oxygen
   A) decreases B) remains constant
   C) first increases and then decreases D) increases
9. Electrovalency of non-metal atom is not equal to, that of the metal atom in
   A) Sodium bromide B) Magnesium oxide

C)Aluminium nitride D) Potassium sulphide

10. Cation is isoelectronic with anion in
A) Sodium chloride B) Potassium Bromide
C) Lithium fluoride D) Rubedium bromide

11. Which of the following has pseudo inert gas configuration
A) Na^+ B) Cu^+ C)K^+ D) S^{--}

12. The Atomic numbers of three elements A. B and C are a, a + 1, and a + 2. C is an alkalimetal. In a compound of A and C, the nature
A) Coordinate B)Covalent C) Ionic D) Metallic

13. An atom with atomic number 20 is most likely to combine chemically with the atom whose atomic number is
A) 11 B) 16 C)18 D)10

14. Duplet configuration is not found in
A) hydride ion B) hydrogen molecule C) Lithium cation D) Be^{3+}

15. If stability were attained with 6 electrons rather than with 8 electrons. What would be the formula of the stable fluoride ion
A) F^{3+} B) F^+ C)F^- D) F^2

16. The maximum valency of an element with atomic number 7 is
A) 2 B)5 C)4 D)3

17. Valency of sulphur in sulphuric acid is
A)2 B)4 C) 6 D)8

18. With the decrease in thermal energy of Gas molecules attaction forces and repulson forces
A) both increases B) both decreases
C) increases, decreases, respectively
D) decreases, increases, respectively

19. The maximum valency of sulphur is
A) 4 B)6 C) 8 D)7

20. Valency of the metal atomwith respect to oxygen is maximum in
A) Mn_2O_7 B) OsO_4 C)MnO_2 D) CrO_3

21. When NaCl is dissolved in water the sodium ion is
A) Oxidised B) Reduced C) Hydrolysed D)Hydrated

22. The electronegativities of two elements are 0.7 and 3.0. the bond formed between them would be
A) Ionic B) Covalent C) Co-ordinate covalent D) Metallic

23. Which of the following is a favourable factor for cation formation?
A) Low ionisation potential B) High electron affinity
C) High electronegativity D) Small atomic size

24. The co-ordination number of the cation in the face centred cubic lattice is
A) 4 B)8 C)3 D)6

25. The number of oppositely charged nearest neighbours to a Caesium ion in Caesium Chloride lattice are
A) 8 B)6 C) 4 D) 2

II. Multi correct answer type questions:

26. It was found that atoms having atomic numbers of 2, 10, 18, 36, 54, 86 are very stable and do not show any chemical reactivity, these elements were found to be gases and are called: A) Inert gases

B) Diatomic gases
C) Monoatomic gases D) Noble gases

27. Which of the following element(s) do not form molecules?
A) Helium B)Oxygen C) Nitrogen D) Argon

28. Which of the following will try to achieve helium configuration?
A) Hydrogen B)Lithium C) Berylium D) None of these

29. The common or group valency is equal to:
A) No. of valence electrons till group number 4.
B) 8 - no. of valence electrons after group number 4.
C) Only no. of electrons present in the valence shell.
D) None of the above.

III. Assertion & Reasoning type:

A) Statement-I, Statement-II both are true and Statement-II is the correct explanation of Statement-I.
B) Statement-I, Statement-II both are true but Statement-II is not the correct explanation of Statement-I.
C)Statement-I is true, Statement-II is false.
D)Statement-I is false, Statement-II is true

30. **Statement I :** Elements which lose electrons are called electropositive elements.
Statement II: Elements which gain electrons are called electronegative elements.

31. **Statement I :** Ionic compounds tend to be non-volatile
Statement II : Inter ionic forces in ionic compounds are weak

32. **Statement I:** Among Ca^{2+} and Zn^{2+} ions, Ca^{2+} is more stable than Zn^{2+}
Statement II: Both Ca^{2+} and Zn^{2+} ions are diamagnetic

IV. Matching type:

33.

Column-I	**Column-II**
a) Sodium	1)2, 8, 8
b) Duplet configuration	2)Stable (or) inactive
c) Xe	3)Makes an element inactive
d) Ar	4)Unstable (or) active
	5) 2, 8,8,18,18

34.

Column-I	**Column-II**
A) Incomplete octet	1) Acetic acid
B) Expansion of octet	2) BCl_3
C) Octahedral Geometry	3) IF_7
D) Dimerisation	4) SF_6

V. Comprehension type:

The Chemical bond formed due to electron transfer is called ionic bond or electro valent bond. Ionic bond will be formed more easily between the elements with low ionization potential and high electron affinity. Energy changes involved during the formation of ionic compound can be calculated by Born – Haber cycle. Lattice enthalpy changes are directly proportional to the stability of ionic compound.

35. Which of the following has electrovalent bond?
A) HCl B) AlF_3 C) CH_4 D) $BeCl_2$

36. Which of the following is more ionic?

A) KF B) NaF C) MgF_2 D) CaF_2

37. Most stable ionic compound among the following is
A) Li_2O B) MgO C)Cs_2O D) KI

38. Born- Haber cycle is based on
A) Faradays law B)Gay-Lumar's law
C)Emetons law D) Hess's law

LEARNER'S TASK

BEGINNERS (Level - I)

I. Single Answer type questions:

1. The electrons generally involved in bonding
A) are those that lie closest to the nucleus
B) are those for which the ionization energies are small
C) belongs to inner shells D) are free electrons

2. Chemical bond formation takes place when
A) energy is absorbed
B)forces of attration overcome forces of repulsion
C) forces of repulsion overcome forces of attraction
D) forces of attraction are equal to forces of repulsion.

3. During bond formation potential energy of the system
A) Increases B)decreases
C) remains the same D)cannot be predicted

4. The maximum number of valence electrons possible for atoms in the second period of the periodic table is
A) 2 B) 8 C)18 D) 32

5. Which of the following covalent molecule is an exception to octet rule?
A) $BeCl_2$ B)CO C)H_2O D)CH_4

6. The molecule that deviates from octet rule is
A)NaCl B)$BeCl_2$ C)MgO D)NH_3

7 Which of the following bond is non polar ?
A) C-H B)O-H C)N-H D)F-F

8. In Covalency
A)Transfer of electrons takes place
B) Sharing of electrons takes place
C)Sharing of electrons by one atom only
D)None of these take place.

9. Potassium forms a highly ionic compound when it combines with
A)Chlorine B)Fluorine C) Bromine D)Iodine

10. Most ionic compound among the following is
A) Sodium fluoride B) Sodium Chloride
C) Sodium bromide D)Sodium iodide

11. Which of the following is not an ionic compound
A)Sodium hydride B) Carborundum

C)Potassium oxide D)Calcium carbide

12. Least ionic compound among the following is
A) NaCl B)KCl C) CsI D) LiI

13. Which of the following is not an ionic compound
A) BaC_2 B)Al_2O_3 C)CaH_2 D)$AlCl_3$

14. The most ionic compound among the following is
A) KCl B) NaCl C) CsI D) CsF

15. The co-ordination number of sodium in sodium chloride is
A) 6 B) 4 C) 8 D) 3

16. Stability of ionic compound is influenced by
A)Electronegativity B) Lattice energy
C) Sublimation energy D) Electron affinity

17. Which of the following is not a property of ionic compounds
A) They are solids
B) They have high melting points
C)They are conductors in molten state
D) They exhibit space isomerism

18. Which of the following conducts electricity
A)Crystalline NaCl B)Fused NaCl
C)Molten sulphur D)Diamond

19. Which of the following is not a correct statement about an ionic compound
A)The higher the temperature, the more the solubility
B) The higher the dielectric constant of the solvent, the more the solubility
C)The higher the dipole moment of the solvent, the more the solubility
D) The higher the lattice energy, the more the solubility

20. In a crystal cations and anions are held together by
A) Electrons B) Electrostatic forces
C) Nuclear forces D)Covalent bonds

21. Fused ionic compounds
A)are insulators B) are used as semi-conductors
C)conduct electricity D) do not conduct electricity

22. Compared with covalent compounds, electro-valent compounds, generally have
A)Low melting points and low boiling points
B) Low melting points and high boiling points
C) High melting points and low boiling points
D) High melting points and high boiling points

23. Most favourable conditions for electrovalency are
A) Low charge on ions, large cation and small anion
B) High charge on ions, small cation and large anion
C) High charge on ions, large cation and small anion
D) Low charge on ions, small cation and large anion

24. An electrovalent compound is made up of
A) Electrically charged particles B) Neutral molecules
C) Neutral atoms D)Electrically charged atom or group of atoms

25. Ionic reactions are
A)Fast B) Slow C) Very slow D) medium

ACHIEVERS (Level - II)

II. Multi correct answer type questions:

26. Atoms can lose or gain _____ number of electrons. A)
1 B) 2 C) 3 D) 4

27. Which of the following true for ionic compounds?
A) They are hard solids
B) They can be broken down into pieces very easily
C) They are soluble in non-polar solvents
D) None of the above

28. Which of the following are true? A)
Ionic compounds exists as solid.
B) Ionic compounds have high melting point and high boiling point.
C) Ionic compounds undergo chemical reactions quickly in aqueous solutions.
D) None of these.

29. Which of the following statements are correct about ionic bond formation?
A) Ionic bond is formed between an atom of low ionisation potential and an atom of high electron affinity.
B) Ionic bond is formed by the transfer of one or more electrons from one atom to the other.
C) Generally oxides, Halides and Sulphides of alkali and alkaline earth metals are ionic
D) None of the above.

30. Among the following which is correct information about the formation of cation?
A) Formation of cation is exothermic. B) In this energy releases.
C) It is an endothermic process. D) It is an energy absorbing process

III. Assertion & Reasoning type

1. Statement-I, Statement-II both are true and Statement-II is the correct explanation of Statement-I.
2. Statement-I, Statement-II both are true but Statement-II is not the correct explanation of Statement-I.
3. Statement-I is true, Statement-II is false.
4. Statement-I is false, Statement-II is true

31. **Statement I :** KF is more ionic than NaCl.
Statement II: Compounds having large cation and small anion is more ionic than compound having small cation and large anion.

32. **Statement I :** Graphite is a good electrical conductor.
Statement II : The free electrons in graphite conducts electricity.

33. **Statement I :** NaCl is bad conductor in the solid state
Statement II : Na^+ and Cl^- ions are not free in the solid state

34. **Statement I :** Ionic compounds exhibits isomerism
Statement II : Ionic bond is non directional bond

IV. Matching type:

35.

Column-I	**Column-II**
a) Ionic compounds in aqeous	1) Good conductor of electricity
b) Ionic compounds in solid state	2) Bad conductor of electricity
c) $ZnSO_4.7H_2O$ and $FeSO_4.7H_2O$	3) Isomorphs
d) Best polar solvent	4) Water
	5) $CHCl_3$

36.

Column-I	**Column-II**
a) C_2H_6	1) Ionic bond
b) Iron wire	2) Metallic bond
c) H_2O	3) Coordinate, covalent bonds
d) H_3O^+	4) Covalent bond

37.

Column I	**Column II**
a) Electron deficent	1) ClF_3
b) odd electron molecule	2) $BeCl_2$
c) Expansion of octet	3) BF_3
d) T shaped molecule	4) NO

V. Comprehension type:

When anions and cations approach each other, the valence shell of anions are pulled towards cation nucleus and thus, shape of anion is deformed, The phenomenon of deformation of anion by a cation is known as polarization and the ability of the cation to polarize the anion is called as polarizing power of cation. Due to polarization, sharing of electrons occurs between two ions to some extent and the bond shows some covalant character.

The magnitude of polarization depends upon a number of factors. These factors were suggested by Fajan and are known as Fajan's rules.

1) Greater is the polarization in a molecule, more is covalent character.

2) As the charge magnitude on cation increases, its tendency to polarize the anion increases.

3) As the size of the cation decreases or size of the anion increases, the polarization increases.

4) The cations with 18 electrons in the outermost shell bring greater polarization of the anion than those with inert gas configuration even both the cations have same size and same charge.

38. In which of the halides, there is maximum polarization?
A) AlF_3 B) $AlCl_3$ C) $AlBr_3$ D) AlI_3

39. Which is most covalent in nature?
A) NaCl B) $MgCl_2$ C) $AlCl_3$ D) $CaCl_2$

40. Which has the minimum melting point?
A) CaF_2 B) $CaCl_2$ C) $CaBr_2$ D) CaI_2

EXPLORERS (Level - III)

Discriptive type

1. Expain ionic bond with examples.
2. Explain the favourable conditions for the formation of ionic bond.
3. explain Fazans rule.

RESEARCHERS (Level - IV)

MCQ's with single correct answer

1. Metal 'M' forms a peroxide of the type MO_2. Valency of the metal with respect to oxygen
   A) 0 B) 1 C) 2 D) 4
2. Electrovalency of non-metal atom is not equal to that of the metal atom in
   A) Sodium bromide B) Magnesium oxide
   C) Aluminium nitride D) Potassium sulphide
3. Valence of sulphur in sulphuric acid is
   A) 2 B) 4 C) 6 D) 8
4. Variable valence is a property of
   A) Alkali metals B) Transition metals
   C) Alkaline earth metals D) Inert gases
5. The molecule that deviates from octet rule is
   A) NaCl B) $BeCl_2$ C) MgO D) NH_3
6. In a crystal cations and anions are held together by
   A) Electrons B) Electrostatic forces
   C) Nuclear forces D) Covalent bonds
7. Most favourable conditions for electrovalence are
   A) Low charge on ions, large cation and small anion
   B) High charge on ions, small cation and large anion
   C) High charge on ions, large cation and small anion
   D) Low charge on ions, small cation and large anion
8. Most ionic bond is present in
   A) LiH B) HF C) CsH D) HI
9. The electronegativities of F,Cl,Br and I are 4.0,3.0,2.8,2.5 respectively. The hydrogen halide with a high percentage of ionic character is
   A) HF B) HCl C) HBr D) HI
10. Ionic reactions are
    A) Fast B) Slow C) Very slow D) medium
11. Melting point is very high for
    A) KCl B) KBr C) KI D) KF
12. Which of the following is not an ionic compound
    A) BaC_2 B) Al_2O_3 C) CaH_2 D) $AlCl_3$

LECTURE TASK.

1. B 2. C 3. B 4. C 5. B 6. A 7. D 8. C 9. D

	10. D	11. B	12. C	13. B	14. D	15. B	16. B	17. C	18. C
	19. B	20. B	21. D	22. A	23. A	24. D	25. A		
II	26.A,C,D		27.A,D	28.A,B,C		29.A,B			
III	30. B	31. C	32. B						
IV	33. a-4,b-2,c-5,d-1				34. a-2,b-3,4,c-4,d-1				
V	35. B	36. A	37. C	38. D					

STUDENT TASK.

LEVEL-I

I	1. B	2. B	3.B	4. B	5. A		6.B	7. D	8. C	9.B
	10. A	11.B	12. D	13.B	14. D	15. A	16. B	17. D	18. B	
	19. C	20. B	21. C	22. D	23. A	24. D	25. A			

LEVEL-II

II	26.A,B,C,D		27.A,C	28.A,B,C		29.A,B,C		30. C,D
III	31.A	32. A	33. A	34. D				
IV	35. a-1,b-2,c-3,d-4				36. a-4,b-2,c-4,d-3			37. a-2,3,b-1,3,4,c-1,d-1
V	38. A	39.C	40.D					
Level - IV	1. C	2. D	3.C	4. B	5. B	6.B	7. A	8. C	9.A
	10. A	11.D	12. D						