CHEMICAL BONDING

LEARNING OBJECTIVES:

- What is a chemical bond
- Type of bonds & their properties
- Lewis dot structure & Octet Rule
- Fazan's Rule
- VSEPR Theory
- Valence bond Theory
- Hybridisation Theory

APPLICATION IN REAL LIFE:

Φ Chemical Bonding has several real time applications in both Living & Non-Living processes.

For example it is used to study the structure & Functioning of DNA, and various cell organelles in the body.

Φ In the manufacture of Various materials like resins, Biodegradable polymers etc..

In the study of various processes like Ion Exchange, Ionizing radiations, Functioning of various semi permeable membranes etc..

Φ Mainly used in the fields of Pharmacy & Chemical Engineering.

§§ **Physical Reason :**

Atoms are less stable and more energetic hence they form molecules, loosing some energy by participating in Chemical bond.

$H + H \rightarrow H_2 + 434.72KJ$

$Cl + Cl \rightarrow Cl_2 + 239.1KJ$

(Chemical bond formation is always Exothermic)

§§ **Chemical Reason :**

All noble gases are very stable chemically due to the completely filled electronic configaration hence all other elements participate in chemical bond inorder to acquire stable configuration.

Under normal conditions most of te elements do not exist as independent atoms.They occur as Molecules, because atoms can't exist independently at ordinary conditions.

An atom or group of atoms which can exist independently at normal conditions is called molecule".

The number of atoms present per molecule depends on the combining capacity of the constituent elements. "This combining capacity is called valency"

In a Chemical bond both attractive and repulsive forces exist in equilibrium.

§§ **Kessel - Lewis Theory**

It is also called as "electronic theory of Valency" this was proposed on the basis of Bohr's Atomic theory.

According to this :

The outer most energy level in an atom is known as valence shell and the electrons present in it are called Valence electrons.

The electrons present in the inner energy levels are known as core electrons.

Elements with eight electrons in their valence shell are more stable than other elements.Hence all elements try to acquire eight electrons in their outer most orbit (octet configuration)

An atom must possess eight electrons in outermost energy level for its stability(octet rule).Eventhough 'He' has only two electrons in the valence shell, it is highly stable and chemically

inert (duplet Configuration)

Atoms attain stable electronic configuration(duplet and octet configuration) either by transfer (or) by sharing of electrons. The number of electrons transfered is called **Electrovalency** and bond resulted is called Electrovalent bond. The number of electrons shared is called **co-valency** and the bond resulted is called covalent bond.

Lewis introduced simple notations to represent valence electrons in an atom. They are called Lewis symbols.

In these symbols valence electrons are represented by dots.

Ex: Li; •Be; •$\dot{B}$; etc

No. of valence electrons	Example	Lewis structure
1	Hydrogen / Group IA	H• / Li•
2.	Helium/Group IIA	Mg:
3.	Group IIIA	•$\dot{B}$•
4.	Group IV A	$\dot{\underset{\cdot\cdot}{\overset{\cdot\cdot}{C}}}$
5.	Group VA	•$\dot{\underset{\cdot\cdot}{\overset{\cdot\cdot}{N}}}$
6.	Group VI A	:$\dot{\underset{\cdot\cdot}{\overset{\cdot\cdot}{O}}}$

§§ Ionic bond : (Electrovalent Bond)

"The strong electrostatic attraction between two oppositely charged ions which are formed due to transfer of electrons from one atom to another in called ionic bond (or) Electrovalent Bond"

Generally ionic bond is formed between a Metal and a non metal.

The atom which gains electrons turn inot anion, and which loses electrons turn into cation.

Formation of ionic bond is a redox process.because one atom undergoes oxidation other one undergoes reduction.

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

$2F + 2e^- \rightarrow 2F^-$

$Mg^{+2} + 2F^- \rightarrow MgF_2$ (or) $Mg^{+2}(F^-)_2$

The maximum electrovalency in ionic bond is 3.

In Mg F_2 electrovalency of Mg = 2, F = 1

In NaO_2 electrovalency of Na = 1, O = 2

Tendency of element to form ionic bonds in relation to their position in periodic table :

¶¶ Factors Favourable for the formation of ionic bond

(a) Factors favourable for cation formaiton

1) Low ionization potential

Atom having very low ionisation potential forms the cation very easily.

(Potassium (IP=495.57kj/mole) forms the cation more readily than sodium (IP=519.82kj/mole)

2) Low charge on the ion

Formation of cation carrying less positive charge is easy . ($Al^{+3} < Mg^{+2} < Na^+$)

3) Large atomic size

Atoms with large atomic size form cations easily ($K^+ > Na^+$)

(Cs^+ ion has the biggest cation among alkali metal ions. Its compounds are more ionic than the corresponding compounds of other alkali metlas).

4) Formation of cation with inertgas configuration

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

Formation of cation having inert gas configuration is very easy.

LiCl is more covalent in nature and so dissolves in non-polar solvents like alcohol or ether.

(b) Factors favorable for anion formation:

1) High electronegative and Electron affinity.

Atom having very high electron effinity / electro negativity forms anion very easily.

$F_2 > O_2 > N_2$

2) Small atomic size

Small non metal atom forms anion very easily.

$(\bar{F} > Cl– > \bar{B}r > \bar{I})$

3) Low charge on the ion

Formation of anion carrying less negative charge is easy.

$(\bar{F} > \bar{O}^2 > \bar{N}^3)$

Formation of anion having inert gas configuration is very easy.

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

§§ **Fajan's rules:**

Based on the phenomenon of Polarisation

Fajan proposed following rules. They are used to know the relative ionic natures.

Fajan's rules are used to predict whether a chemical bond will be covalent (or) ionic.

It depends on the charge of the cation and anion, and the relative size of cation and anion.

(a) Ionic nature α size of cation

α 1/size of anion

(b) Ionic nature α 1/charge on cation

α 1/charge on anion

Cations with inert gas configurations form ionic compounds while those cations with psuedo inert gas configurations favour covalent bond formation.

¶¶ **A compound is more ionic (or) less covalent if it contains.**

1) Large cation and small anion.

2) Cation carrying less positive charge and anion carrying less negative charge.

3) Cation having inert gas configuration.

NaCl > CuCl

¶¶ **A compound is less ionic (or) more covalent if it contains.**

1) small cation and large anion.

2) Cation carrying high positive charge and anion carrying high negative charge.

3) Cation having pseudo inert gas configuration.

In a binary compound AB, if the electro negativity difference between the elements A and B is.

equal to 1.7, the compound AB is 50% ionic.

greater than 1.7, the compound AB is an ionic compound.

less than 1.7, the compound AB is a covalent compound.

§§ **Crystal structure of ionic compounds**

The arrangement of ions in the crystal of an ionic solid is known as its lattice arrangement.

The smallest part of the crystal of an ionic compound that represents its lattice arrangement is known as the **unit cell.**

The crystal of an ionic solid is a combination of different unit cells.

The ions packed in a crystalline substance are shown by points in a crystal lattice. These points are called lattice points. In different cubic unit cells there are mainly four kinds of lattice points. They are

§§ **Co-ordination number**

The number of oppositely charged ions, that surround an ion at nearest possible distances in an ionic crystal is known as the **co-ordination number** of that ion.

Example:

Co-ordination number of Na^+ or Cl^-. in NaCl is six.

Ratio of co-ordination numbers of cation and anion in NaCl = 6 : 6

Co-ordiantion number of Cs^+ or Cl^- in CsCl = 8 : 8

The co-ordination number depends on radius ratio of the ionic crystal.

§§ **Properties of Ionic Compounds:**

1) Ionic compounds exist as solids. since electrostatic forces of attraction are extending in all directions, each ion tends to gather as many of opposite kind ions around it self.

2) A nonbonding array of alternate positive and negative ions exist. As a result no isolated decrete molecule exist in the Crystal in lattice, gaint molecules are formed in the crystal.

3) Ionic compounds have high melting points and high boiling points.
(Melting pint of NaCl = 803°C)

4) Ionic compounds dissolve in polar solvents.

5) Ionic compounds are good electrical conductors in molten state (or) in aqueous solutions.

6) Ionic compounds undergo chemical reactions quickly in aqueous solutions.
$NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$ white ppt.

7) Ionic compounds do not exhibit space isomerism because ionic bond is a non directional bond.

8) The melting and boiling points of ionic compounds are very high. This is due to the presence of strong electrostatic forces of attraction between the ions.

9) If anion is common in the ionic compounds more ionic compond will have more melting point and less ionic compound will have less melting point.

Example: Melting point of $BaCl_2$ is very high compared with $BeCl_2$.

Melting point of CsF is very high compared with LiF.

10) If cation is common in the ionic compounds, compound with high lattice energy will have high m.p. and the compound with low lattice energy will have low m.p

Example: Melting point of NaF is more than that of NaI.

Melting point of CaF_2 is more than that of CaI_2.

TEACHING TASK

I. Single Answer type questions:

1. The number of valency electrons and the valency with respect to hydrogen are equal for
1. Sulphur 2. Silicon 3. Phosphorus 4. Chlorine

2. The element having highest valency with respect to oxygen is
1. Sodium 2. Aluminium 3. Chlorine 4. Sulphur

3. Metal 'M' forms a peroxide of the type MO_2. Valency of the metal with respect to oxygen
1. 0 2. 1 3. 2 4. 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
1. A_2B 2. AB 3. AB_2 4. 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
1. A B 2. $A_2 B_3$ 3. A_3B_2 4. 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
1. $X Y_2$ 2. $X_5 Y_2$ 3. $X_2 Y_5$ 4. $X Y_5$

7. Which of the following exhibits variable valency
1. Na 2. H 3. Al 4. S

8. In a short period, as the atomic number increases, the valency of elements with respect to oxygen
1. decreases 2. remains constant
3. first increases and then decreases 4. increases

9. Electrovalency of non-metal atom is not equal to, that of the metal atom in
1. Sodium bromide 2. Magnesium oxide
3.Aluminium nitride 4. Potassium sulphide

10. Cation is isoelectronic with anion in
1. Sodium chloride 2. Potassium Bromide
3.Lithium fluoride 4. Rubedium bromide

11. Which of the following has pseudo inert gas configuration
1. Na^+ 2. Cu^+ 3. K^+ 4. S^{--}

12. The Atomic numbers of three elements A. B and C are a, a + 1, and a + 2. C is an alkali metal. In a compound of A and C, the nature
1. Coordinate 2. Covalent 3. Ionic 4. Metallic

13. An atom with atomic number 20 is most likely to combine chemically with the atom whose atomic number is
1. 11 2. 16 3. 18 4. 10

14. Duplet configuration is not found in
1.hydride ion 2. hydrogen molecule 3. Lithium cation 4. 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
1. F^{3+} 2. F^+ 3. F^- 4. F^2

16. The maximum valency of an element with atomic number 7 is
1. 2 2. 5 3. 4 4. 3

17. Valency of sulphur in sulphuric acid is
1.2 2.4 3.6 4.8

18. With the decrease in thermal energy of Gas molecules attaction forces and relulson forces
1. both increases 2. both decreases
3. increases, decreases, respectively 4. decreases, increases, respectively

19. The maximum valency of sulphur is
1. 4 2. 6 3. 8 4. 7

20. When NaCl is dissolved in water the sodium ion is
1. Oxidised 2. Reduced 3. Hydrolysed 4. Hydrated

21. The electronegativities of two elements are 0.7 and 3.0. the bond formed between them would be
1. Ionic 2. Covalent 3. Co-ordinate covalent 4. Metallic

22. Which of the following is a favourable factor for cation formation?
1. Low ionisation potential 2. High electron affinity

3. High electronegativity 4. Small atomic size

II. Multi correct answer type questions:

♦ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which ONE or MORE is correct. Choose the correct options*

23. 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:
1. Inert gases 2. Diatomic gases 3. Monoatomic gases 4. Noble gases

24. Which of the following element(s) do not form molecules?
1. Helium 2. Oxygen 3. Nitrogen 4. Argon

25. Which of the following will try to achieve helium configuration?
1. Hydrogen 2. Lithium 3. Berylium 4 None of these

26. The common or group valency is equal to:
1. No. of valence electrons till group number 4.
2. 8 - no. of valence electrons after group number 4.
3. Only no. of electrons present in the valence shell.
4. None of the above.

III. Assertion & Reasoning type:

♦ *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which ONLY ONE is correct Choose the correct option.*

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

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

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

29. 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:

♦ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in Column–I have to be matched with statements (p, q, r, s) in Column–II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*
*If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

30.

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

31.

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:

This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which ONLY ONE is correct. Choose the correct option.

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.

32. Which of the following has electrovalent bond?
1. HCl 2. AlF_3 3. CH_4 4. $BeCl_2$

33. Which of the following is more ionic?
1. KF 2. NaF 3. MgF_2 4. CaF_2

34. Most stable ionic compound among the following is
1. Li_2O 2. MgO 3. Cs_2O 4. KI

35. .Born- Haber cycle is based on
1. Faradays law 2. Gay-Lumar's law 3. Emetons law 4. Hess's law

LEARNER'S TASK

BEGINNERS (Level - I)

I. Single Answer type questions:

1. The electrons generally involved in bonding
1. are those that lie closest to the nucleus
2. are those for which the ionization energies are small
3. belongs to inner shells 4. are free electrons

2. Chemical bond formation takes place when
1. energy is absorbed 2. forces of attration overcome forces of repulsion
3. forces of repulsion overcome forces of attraction
4. forces of attraction are equal to forces of repulsion.

3. During bond formation potential energy of the system
1. Increases 2. decreases
3.remains the same 4.cannot be predicted

4. The maximum number of valence electrons possible for atoms in the second period of the periodic table is
1. 2 2. 8 3. 18 4. 32

5. Which of the following covalent molecule is an exception to octet rule?
1. BeCl 2. CO 3. H_2O 4. CH_4

6. The molecule that deviates from octet rule is
1. NaCl 2. $BeCl_2$ 3. MgO 4. NH_3

7. Which of the following bond is non polar ?
1. C-H 2. O-H 3. N-H 4. F-F

8. In Covalency

1.Transfer of electrons takes place 2.Sharing of electrons takes place
3.Sharing of electrons by one atom only 4.None of these take place.

9. Potassium forms a highly ionic compound when it combines with
1. Chlorine 2. Fluorine 3. Bromine 4. Iodine

10. Most ionic compound among the following is
1. Sodium fluoride 2. Sodium Chloride
3. Sodium bromide 4.Sodium iodide

11. Which of the following is not an ionic compound
1. Sodium hydride 2. Carborundum
3. Potassium oxide 4.Calcium carbide

12. Least ionic compound among the following is
1. NaCl 2. KCl 3. CsI 4. LiI

13. Which of the following is not an ionic compound
1. BaC_2 2.Al_2O_3 3. CaH_2 4. $AlCl_3$

14. The most ionic compound among the following is
1. KCl 2. NaCl 3. CsI 4. CsF

15. The co-ordination number of sodium in sodium chloride is
1. 6 2. 4 3. 8 4. 3

16. Stability of ionic compound is influenced by
1. Electronegativity 2. Lattice energy
3. Sublimation energy 4. Electron affinity

17. Which of the following is not a property of ionic compounds
1. They are solids 2. They have high melting points
3. They are conductors in molten state 4. They exhibit space isomerism

18. Which of the following conducts electricity
1. Crystalline NaCl 2. Fused NaCl 3. Molten sulphur 4. Diamond

19. Which of the following is not a correct statement about an ionic compound
1. The higher the temperature, the more the solubility
2. The higher the dielectric constant of the solvent, the more the solubility
3. The higher the dipole moment of the solvent, the more the solubility
4. The higher the lattice energy, the more the solubility

20. In a crystal cations and anions are held together by
1. Electrons 2. Electrostatic forces 3. Nuclear forces 4.Covalent bonds

21. Fused ionic compounds
1. are insulators 2. are used as semi-conductors
3. conduct electricity 4. do not conduct electricity

22. Compared with covalent compounds, electro-valent compounds, generally have
1. Low melting points and low boiling points
2. Low melting points and high boiling points
3. High melting points and low boiling points
4. High melting points and high boiling points

23. An electrovalent compound is made up of
1. Electrically charged particles 2. Neutral molecules
3. Neutral atoms 4. Electrically charged atom or group of atoms

24. Ionic reactions are
1. Fast 2. Slow 3. Very slow 4. medium

ACHIEVERS (Level - II)

Descriptive type questions

25. Identify the atoms in each of the following compounds which do not obey octet rule.

SO_2, BF_3, OF_2, PCl_5, SiF_4, PCl_3

26. Show the formation of an ionic compound lithium sulphide.

27. Assuming the following elements combine to form ionic compounds, Write the formulae of the compounds. a) Sr and Cl b) Rb and S c) Al and S d) Ca and N

28. Discuss two conditions that are essential for two atoms to form an ionic bond.

29. Draw the lewis electron-dot structure for the following

a) hydrogen b) fluorine c) neon d) nitrogen e) calcium

EXPLORERS (Level - III)

II. Multi correct answer type questions:

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which ONE or MORE is correct. Choose the correct options

30. Atoms can lose or gain _____ number of electrons.

1. 1 2. 2 3. 3 4. 4

31. Which of the following true for ionic compounds?

1. They are hard solids
2. They can be broken down into pieces very easily
3. They are soluble in non-polar solvents
4. None of the above

32. Which of the following are true?

1. Ionic compounds exists as solid.
2. Ionic compounds have high melting point and high boiling point.
3. Ionic compounds undergo chemical reactions quickly in aqueous solutions.
4. None of these.

33. Among the following which is correct information about the formation of cation?

1. Formation of cation is exothermic. 2. In this energy releases.
3. It is an endothermic process. 4. It is an energy absorbing process

III. Assertion & Reasoning type:

This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which ONLY ONE is correct Choose the correct option.

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

34. **Statement I :** KF is more ionic than NaC*l*.
Statement II: Compounds having large cation and small anion is more ionic than compound having small cation and large anion.

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

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

37. **Statement I :** Ionic compounds exhibits isomerism

Statement II : Ionic bond is non directional bond

38. **Statement I :** The lewis symbol for aluminium is $\bullet \dot{Al} \bullet$

Statement II : The outermost shell electronic configuration of Al is $3s^2\ 3p^1$

IV. **Matching type:**

This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in Column–I have to be matched with statements (p, q, r, s) in Column–II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

*If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

39.

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) $CHCl_3$

40.

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

41.

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

42.

Column-I	**Column-II**
a) Neon	1) $: \dot{\underset{\cdot}{N}} \bullet$
b) Nitrogen	2) $: \dot{\underset{\cdot\cdot}{\overset{\cdot\cdot}{Ne}} :$
c) Boran	3) $Be:$
d) Berylium	4) $\bullet \dot{B} \bullet$

V. **Comprehension type:**

This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which ONLY ONE is correct. Choose the correct option.

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.

43. In which of the halides, there is maximum polarization?

1. AlF_3 2. $AlCl_3$ 3. $AlBr_3$ 4. AlI_3

44. Which is most covalent in nature?

1. NaCl 2. $MgCl_2$ 3. $AlCl_3$ 4. $CaCl_2$

45. Which has the minimum melting point?

1. CaF_2 2. $CaCl_2$ 3. $CaBr_2$ 4. CaI_2

VI. <u>Higher Order Thinking Questions.</u>

46. Among the following the stable electronic configuration is

1.singlet 2.triplet 3.octet 4.quartet

47. Among the following the elements without stable electronic configuration are

1. Krypton 2.Chlorine 3.Xenon 4.Aluminium

48. Lewis dot symbol of an element X is $\cdot\overset{\cdot\cdot}{\underset{\cdot\cdot}{X}}\cdot$, and X contains five shells then X is

1.Te 2.In 3.Sn 4.I

49. Which of the following statements are correct about ionic bond formation?

1. Ionic bond is formed between an atom of low ionisation potential and an atom of high electron affinity.
2. Ionic bond is formed by the transfer of one or more electrons from one atom to the other.
3. Generally oxides, Halides and Sulphides of alkali and alkaline earth metals are ionic
4. None of the above.

50. Most favourable conditions for electrovalency are

1. Low charge on ions, large cation and small anion
2. High charge on ions, small cation and large anion
3. High charge on ions, large cation and small anion
4. Low charge on ions, small cation and large anion

51. The co-ordination number of the cation in the face centred cubic lattice is

1. 4 2. 8 3. 3 4. 6

52. The number of oppositely charged nearest neighbours to a Caesium ion in Caesium Chloride lattice are

1. 8 2. 6 3. 4 4. 2

53. Valency of the metal atomwith respect to oxygen is maximum in

1. Mn_2O_7 2. OsO_4 3. MnO_2 4. CrO_3

KEY

ΦΦ TEACHING TASK :

1. 2	2. 3	3. 2	4. 3	5. 2	6. 1	7. 4	8. 3	9. 4	
10. 4	11. 2	12. 3	13. 2	14. 4	15. 2	16. 2	17. 3	18. 3	
19. 2	20. 2	21. 4	22. 1	23.1,3,4	24.1,4		25.1,2,3		26.1,2
27. 2	28. 3	29. 2	30. a-4,b-2,c-5,d-1			31. a-2,b-3,4,c-4,d-1			
32. 2	33. 1	34. 3	35. 4						

ΦΦ LEARNER'STASK :

☐ **BEGINNERS :**

1. 2	2. 2	3. 2	4. 2	5. 1	6.2	7. 4	8. 3	9.2
10. 1	11. 2	12. 4	13. 2	14. 4	15. 1	16. 2	17. 4	18. 2
19. 3	20. 2	21. 3	22. 4	23. 1	24. 4			

☐ **EXPLORERS :**

30.1,2,3,4	31.1,2	32.1,2,3	33.1,2,3	34.1	35. 1	36. 1	37. 4	38. 2
39. a-1,b-2,c-3,d-4		40. a-4,b-2,c-4,d-3			41. a-2,3,b-1,3,4,c-1,d-1			
42.a-2,b-1,c-4,d-3		43. 1	44. 3	45.4	46.3	47.2,4		48.4
49.1,2,3	50.1	51.4	52.1	53.2				

§§ Covalent bond

Covalent bond was proposed by G.N. Lewis.

The bond formed between two atoms by the mutual sharing of their valency electrons is known as covalent bond.

Only unpaired electrons present in the atom involve in covalent bonds.

One unpaired electron involves in one covalent bond only.

The number of covalent bonds in which an atom involves is equal to the number unpaired electrons present in it.

The atom forms less number of covalent bonds in its ground state.

The atom forms more number of covalent bonds in its excited state.

Phosphorus atom has three unpaired electron in its group state. So it can form only three covalent bonds in its ground state,

Phosphorus atom has five unpaired electrons in its excited state. So it can form five covalent bonds in its excited state.

Single bond is formed by the mutual sharing of one pair of electrons between two atoms.

Single bond is represented as '—'

Double bond is formed by the mutual sharing of two pairs of electrons between two atoms.

Double bond is represented as '=='

Triple bond is formed by the mutual sharing of three pairs of electrons between two atoms. It is represented as '≡'

Double and triple bonds are called multiple bonds.

Pure covalent bond is formed by the sharing of electron pairs between two like atoms. The word like atoms stands for atoms of the same element (or) atoms having same electro negativity value.

Pure covalent bond is present in $H_2, Cl_2, O_2, N_2, P_4, S_8$ etc.

Polar covalent bond is formed by the mutual sharing of electron pairs between two dissimilar atoms.

The word dissimilar atoms stands for atoms of different elements (or) atoms having different electro - negativity values.

Polar covalent bond is present in $HF, HCl, ICl, H_2O, CO_2, SO_2, BeCl_2, SO_3$ $BCl_3, NH_3, CH_4, PCl_5, SF_6$ etc.

The unpaired electrons present in the valency shell of an atom involve in covalent bonds, the remaining electron pairs present in its valency shell are called lone pairs of electrons (or) non bonded pairs of electrons.

The lone pairs of electrons present in the atom involve in co-ordinate covalent bonds.

Molecule	**Central Atom**	**Total no. of valence electrons in thecentral atom**
CH_4	C	8 (Octet)
NH_3	N	8 (Octet)
H_2O	O	8 (Octet)
CO_2	C	8 (Octet)
C_2H_6	C (each)	8 (Octet)
C_2H_4	C (each)	8 (Octet)
C_2H_2	C (each)	8 (octet)
$BeCl_2$	Be	4 (Contracted Octet)
BCl_3	B	6 (Contracted Octet)
PCl_5	P	10 (Contracted Octet)
SF_6	S	12 (Expanded octer)
IF_7	I	14 (Expanded Octet)

§§ **Properties of Covalent Compounds:**

Covalent substances exist as solids, liquids and gases.

Covalent substances have low melting and boiling points.

Covalent substances dissolve in non-polar solvents.

Covalent substances are not electrical conductors either in molten state or in aqueous solutions.

Covalent substances involve in chemical reactions very slowly.

Covalent compounds exhibit space isomerism because covalent bond is a directional bond.

Covalent substances contain individual molecules.

The force of attraction between the molecules is known as vanderwaal's force of attraction.

Vanderwaal's forces of attractions are of the order of 1K.cal/mole.

Vanderwaal's force of attraction is maximum in solids and minimum in gases.

Vanderwaal's force of attraction is proportional to the molecular weight of the substance.

The melting and boiling points of covalent compounds are proportional to their molecular weights.

The melting and boiling points of covalent polymers are very high.

Examples for covalent polymers are Diamond, Graphite, Boron, Silicon, Silica, Boron nitride, Boron Carbide and Silicon carbide.

Covalent subtances do not contain free electrons or free ions. So they are not electrical conductors.

Graphite contains free electrons. So it is a good conductor of electricity.

HCl, HBr, HI, HNO_3 and H_2SO_4 etc are covalent compounds. The aqueous solutions of these substances are good electrical conductors because they contain free ions.

Covalent substances involve in chemical reactions slowly because molecules take part in the

reactions.

$CCl_4, CHCl_3, CH_2Cl_2$ etc cannot give white precipitate with $AgNO_3$ in aqueous solutions because they do not contain chloride ions as they are covalent compounds. The solubility of a covalent substance is more in a solvent having high dielectric constant and less in a solvent having low dielectric constant.

The dielectric constant of a solvent is a measure of its capacity to break the covalent molecules into ions.

Polar solvents have high dielectric constants.

Non polar solvents have low dielectric constants.

Dielectric constant is high for solvents like water, ammonia, hydrofluoric acid etc.

Dielectric constant is low for solvents like Benzene,Carbon disulphide,carbon tetrachloride etc.

TEACHING TASK

I. Single Answer type questions:

1. Which of the following is highly covalent
1. AlF_3 2. $AlCl_3$ 3. $AlBr_3$ 4. CCl_4

2. The compound having more covalent nature is
1. $BaCl_2$ 2. $MgCl_2$ 3. $SrCl_2$ 4. $BeCl_2$

3. Which of the following has a tendency to form covalent compounds
1. Ba 2. Be 3. Na 4. Ca

4. Triple bond is not present in
1. Cyanogen 2. propyne 3. Nitrous Oxide 4. Nitrogen dioxide

5. Number of bonded electrons in ethane molecule are
1. 7 2. 12 3. 10 4. 14

6. Molecule which contains only bonded pairs of electrons on the central atom is
1. H_2O 2. NH_3 3. $BeCl_2$ 4. BrF_3

7. The number of electron pairs involved in the formation of hydrogen cyanide molecule are
1. two 2. eight 3. three 4. four

8. Compound having maximum number of bonded pairs of electrons in its molecule is
1. Ethane 2. Ammonia 3. Sulphur hexafluoride 4.Bromine Pentafluoride

9. The number of electron pairs present in the valency shell of central atom in SF_6 molecule are
1. 4 2. 6 3. 8 4. 7

10. Molecule having maximum number of lone pairs of electrons on central atom is
1. PH_3 2. H_2S 3. CH_4 4. BrF_5

11. Number of bonded pairs and lone pairs of electrons present in the central atom of ammonia molecule are
1. 3,1 2. 2,2 3. 1,3 4. 4,0

II. Multi correct answer type questions:

◆ ***This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which ONE or MORE is correct. Choose the correct options***

12. Which of the following are correct about covalent bond?
1. It is formed by sharing of the electrons
2. It is stronger than ionic bond
3. Its study was done by Kossel
4. When two non-metals are combined, then a covalent bond is formed

13. Which of the following are correct?
1. The bond formed between two non-metallic elements is covalent bond.
2. The bond formed between two inert gas elements is van der Wall's bond.
3. The bond formed between a metal and a non-metal is electrovalent bond.
4. The bond formed between two metallic elements is an ionic bond.

III. Assertion & Reasoning type:

- ***This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which*** *ONLY ONE* ***is correct Choose the correct option.***

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

14. *Statement I*:The covalent bond between a pair of two atoms is represented by a small line (–).
Statement II : G.N.Lewis explained covalent bond foundation by the electron dot structure.

15. Statement-I : BeF_2 is predominantly a covalent compound.

Statement-II: Electronegativity difference between Be and F is too small

16. Statement-I : In H_2 molecule one electron pair is shared between two H- atoms

Statement-II :Hydrogen atom requires one electron to acquire the stable electronic cofiguration of helium

IV. Matching Type:

- ***This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in*** *Column–I* ***have to be matched with statements (p, q, r, s) in*** *Column–II.* ***The answers to these questions have to be appropriately bubbled as illustrated in the following example.***
  If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

17.

List-I	**List-II**
A) Electro valency	1) 25% s-character
B) Sigma bond	2) Transfer of electrons
C) Dipole moment	3) Structure of molecule
D) SP^3 hybdridisation	4) Coulombo-metre
	5) Lewis

18.

List-I	**List-II**
A) NO^-_3ion	1) Molecular solids
B) Isosters	2) Planner structure
C) Ionic bonds	3) CO_2,N_2O
D) Ice and S_8	4) Non direction bonds
	5) Isostrucural with CH_4

V. Comprehension type:

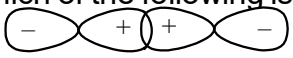
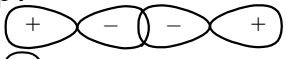
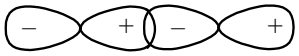
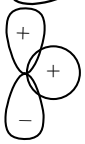
- ***This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which*** *ONLY ONE* ***is correct. Choose the correct option.***

When half-filled valence orbital of one atom overlaps with half-filled valence orbital of other atom, a covalent bond is formed. Head on or axial overlap leads to the formation of sigma bond.

sidewise or lateral overlap of atomic orbitals give rise to the formation of π-bond. In case of π-bond, the probability of finding the shared electron cloud is zero along the line joining two nuclei while the probability of ding the shared electron cloud is maximum along the inter nuclear axis.

19. If x-axis is the internuclear axis then which of the following combination will result into the formation of π-bond?
1. s +$2p_x$ 2. $2p_x + 2p_x$ 3. $2p_y + 2p_y$ 4. s + s

20. Sigma bonds are :
1. Cylindrically symmetrical about the bond axis
2. Perpendicular to the bonds axis
3. asymmetrical about the bond axis
4. none of the above

21. Which of the following is called negative overlap?
1. 
2. 
3. 
4. 

LEARNER'S TASK

BEGINNERS (Level - I)

I. Single Answer type questions:

1. The compound having least covalent nature is
1. $AlCl_3$ 2. $MgCl_2$ 3. NaCl 4. KCl

2. Maximum covalent nature can be seen in
1. CsCl 2. RbI 3. MgF_2 4. LiI

3. Maximum covalency of nitrogen is
1. 4 2. 5 3. 3 4. 6

4. Only triple bond is present in
1. N_2O 2. CO_2 3. HCN 4. N_2

5. Pure covalent double bond is present in
1. acetylene 2. carbon dioxide 3. ethylene 4. Ethane

6. Molecule having maximum number of covalent bonds is
1. NH_4OH 2. NH_4Cl 3. $CO[NH_2]_2$ 4. CH_3OH

7. The molecule which contains maximum number of electrons is
1. CH_4 2. CO_2 3. NO_2 4. N_2O

8. In which of the following molecule, the central atom has three lone pairs of electrons
1. Ammonia 2. Xenon difluoride
3. Chlorine trifluoride 4. Hydrogen sulphide

9. Number of lone pairs of electrons in 9 gms. of water are [N = Avogadro Number]
1. 2N 2. N / 2 3. N 4. N / 4

10. Molecule which contains 4 bonded pairs and 2 lone pairs of electrons on the central atom is
1. XeF_2 2. CO_2 3. XeF_4 4. SF_6

11. Which of the following is a highly polar molecule
1. HCl 2. HF 3. H_2S 4. NH_3

ACHIEVERS (Level - II)

Descriptive type questions

12. Write down the electron-dot structure of nitrogen molecule.

13. Write the difference between ionic and covalent bond.

14. Which type of bond is formed when the atoms have
i) Zero difference in electronegativity ii) Little difference in electronegativity .
iii) Large difference in electronegativity

EXPLORERS (Level - III)

Multi correct answer type questions:

- ***This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which*** *ONE or MORE* ***is correct. Choose the correct options***

15. In which of the following molecule(s), multiple bond is present:
1. CO_2 2. O_2 3. N_2 4. HCN

16. Which is/are characteristics of Pi bond ?
1. a Pi –bond is formed when a sigma bond is already formed.
2. Pi-bonds are formed by un hybrid orbitals.
3. Pi-bonds may be formed by the overlapping of P-Orbitals.
4. Pi-bonds results form lateral overlap of atomic orbitals.

17. Which statement is /are correct
1. sigma bond is stronger than pi bond.
2. sigma bond is formed by the axial overlaping of orbitals.
3. sigma bond is weaker than pi bond.
4) pi bond can exist independently.

Assertion & Reasoning type:

- ***This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which*** *ONLY ONE* ***is correct Choose the correct option.***

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

18. **Statement I:** In a sigma bond end to end overlap of orbitals takes place
Statement II : A sigma bond is weaker than Pi bond

19. **Statement I:** SiF_4 has octet configuration, but acts as an electron pair acceptor
Statement II: Central atom of Si has vacant d-orbitals is its valence shel

Matching type:

- ***This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in*** *Column–I* ***have to be matched with statements (p, q, r, s) in*** *Column–II.* ***The answers to these questions have to be appropriately bubbled as illustrated in the following example.***
If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

20.

List-I	**List-II**
A) Ionic bond	1) Eight electrons in the outermost orbit

	B) Covlant bond	2) NaCl
	C) Valency	3) Number of electronsin the outermost orbit
	D) Octet rule	4) H_2O
		5) Lone pair of electrons

21.	**List-I**	**List-II**
	A) Mettalic bond	1) Drudge
	B) Covlant bond	2) Sidwick
	C) Dative bond	3) Lewis
	D) Ionic bond	4) Kossel

Comprehension type:

♦ ***This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which*** *ONLY ONE is* ***correct. Choose the correct option.***

The attractive forces holding various constituents together in different chemical species is called chemical bond. The bond between two atoms is formed in general to complete the octet of their valence shell. However, in certain cases stable bonds are even formed in that state in which the octet of valence shell of bonding atoms is not complete. The main theories explaining the reasons of bond formation are octet rule, valence bond theory and the molecular orbital theory. The main questions which have to be answered by these theories are

(i) What is the need of atoms to combine with each other?

(ii) What type of forces bond the atoms in a molecule?

(iii) Why a molecule contains definite number of atoms combined in a fixed ratio?

22. In which compounds octet of all the atoms in their valence shell is not complete

1. CH_4 2. CO_2 3. BF_3 4. OF_2

23. In which compounds expansion of octet of valence shell has occurred of the central atom

1. PCl_3 2. PCl_5 3. SO_3 4. H_2S

24. The covalent bond exists in the compound

1. NaCl 2. MgO 3. BaF_2 4. SF_2

Higher Order Thinking Questions.

25. Among the following the non polar molecule is

1.BCl_3 2.NCl_3 3.KF 4.H_2O

26. Among the following the molecules having polar covalent bond is

1.H_2 2.F_2 3.N_2 4.HF

27. The molecules which does not obey octet rule are

1.PF_5 2.SF_6 3.SO_2 4.CO_2

28. Among the following, non-polar covalent compounds are soluble in

1.Water 2.Benzene 3.Ether 4.Acetone

29. If the shared electron pair does not lie in central position of two atoms X and Y, then the bond formed between X and Y is

1.Ionic bond 2. Nonpolar bond 3.Dative bond 4.polare bond

30. Among the following,molecules which have non-directional bonds is

1.NCl_3 2.RbCl 3.$Becl_2$ 4.BCl_3

KEY

ΦΦ TEACHING TASK :

1. 4	2. 4	3. 2	4. 4	5. 4	6. 3	7. 4	8. 1	9. 2	10. 4
11. 1	12.1,4	13.1,2,3	14. 2	15. 3	16.2		17. a-2,b-5,c-4,d-1		

18. a-2,b-3,c-4,d-1 19. 3 20. 1 21. 3

ΦΦ LEARNER'STASK :

☐ **BEGINNERS :**

1. 1 2. 4 3.1 4. 4 5. 3 6. 3 7. 3 8. 2 9. 3 10. 3 11. 2

☐ **EXPLORERS :**

15.1,2,3,4 16.1,2,3,4 17. 1,2 18. 3 19. 1 20. a-2,b-4,c-3,d-1
21. a-1,b-3,c-2,d-4 22. 3 23. 2 24. 4 25.1 26.4 27.1,2
28.2,3,4 29.1 30.2

§§ Co-ordinate covalent bond (or) Dative bond

Co-ordinate covalent bond is also known as dative bond or semi polar bond.

Co-ordinate covalent bond was proposed by Sidgewick. The name dative bond was proposed by Langmuir.

The bond formed between two atoms by the sharing of an electron pair of one atom between two atoms is known as the co-ordinate covalent bond.

Co-ordinate covalent bond is represented by an arrow $(\rightarrow)$ the head of which is close to the atom which accepts the electron pair.

For all practical purposes, the co-ordinate covalent bond is treated as a single cova lent bond.

The formation of co-ordinate covalent bond occurs only after the formation of covalent bonds.

Co-ordinate covalent bond is present in

n Molecules like: $N_2O, O_3, H_2O_2, BF_3, N_2O_4, N_2O_5, CO, F_3B-NH_3, B_3N_3H_6, Al_2Cl_6$

n Ions like: $H_3^+O, NH_4^+, NO_3^-, BF_4^-, N_2H_5^+, C_6H_5NH_3^+$

In a hydrated cation the bond between water molecule and cation is dative bond. Every water molecule involves in one dative bond only.

Example: $\left[Al(H_2O)_6\right]^{+++}$ ion contains 6 dative bonds.

§§ HYDROGEN BOND

Hydrogen bond is a weak electrostatic bond present between positively charged hydrogen atom of a polar covalent bond and a highly electronegative atom carrying negative charge. The highly electronegative atom may be present in the same molecule (or) in a different molecule.

Hydrogen bond was proposed by Latimer and Rodebush.

Hydrogen bond is represented by a dotted line (——).

The length of the hydrogen bond depends on the substance under investigation. It varies from $1.76^0 A$ to $2.75^0 A$.

The energy of hydrogen bond varies from 2 to 10 K.cals/mole.

Hydrogen bond is weaker than covalent bond and stronger than vanderwaals force of attraction.

Most electronegative atoms like Fluorine, Oxygen, Nitrogen only can involve in hydrogen bond. Chlorine atom very rarely involves in hydrogen bond.

Hydrogen bond present in the same molecule is known as **intra molecular hydrogen bond.**

The intra molecular hydrogen bond is present in substances like

O- Chlorophenol, O- Nitro phenol, O- Nitro aniline,

O- Hydroxy benzaldehyde (Salicylaldehyde)

O- Hydroxy benzoic acid (Salicyclic acid)

Substances having intramolecular hydrogen bonds.

are less water soluble.

are steam volatile.

have low boiling points.
no molecular association occurs.

Hydrogen bond present between different molecules is known as **inter molecular hydrogen bond.**

The inter molecular hydrogen bonds are present in substances like water, ammonia, hydrofluoric acid, ortho phosphoric acid, ortho boric acid, p- nitro phenol,

p-chloro phenol, p- hydroxy benzaldehyde, p- hydroxy benzoic acid, Primary alcohols (CH_3OH, C_2H_5OH), fatty acids $(HCOOH, CH_3COOH)$ and primary amines.

Substances having inter molecular hydrogen bonds.
are water soluble.
are not steam volatile.
have high boiling points.
molecular association occurs.

TEACHING TASK

I. Single Answer type questions:

1. A species which has co-ordinate covalency is
1. H_2O 2.BF_3 3. NH_3 4. NH_4^+

2. Co-ordinate bond is not present in
1. NH_4^+ 2. HNO_3 3. H_2O 4. CO

3. Dative bond is present in
1. SO_3 2. BF_3 3.NH_3 4. HF

4. The bonds present in the molecule $\left[Al(H_2O)_6\right]^{+++}$
1. ionic 2. covalent 3. co-ordinate co-valent 4. Ionic and covalent

5. NH_4Cl contains
1. covalent bond 2. coordinate covalent bond 3. ionic bond 4. all the three

6. An element 'Y' has gaseous state configuration is 2,8,8. The type of bond that exist between the atoms of y is
1. Ionic 2. Covalent 3. Metalic 4. Vander waal's

7. The type of bond present in K_3 [Fe $(CN)_6$] is
1. Ionic 2. covalent 3. co-ordinate 4. all the above

8. The type of bonds present in $CuSO_4$. $5H_2$ O are only
1. Electrovalent and covalent 2. electrovalent and coordinate covalent
3. electrovalent,covalent and coordinate colavent
4. covalent and coordinate colavent

9. BF_3 forms an adduct with NH_3 because
1. Nitrogen has high electronegativity
2. boron has high electronegativity
3. boron has an empty P-orbital and nitrogen has lone pair of electrons
4. boron has electro positive character.

10. Which if the following does not contain coordinate bond
1. BH_4^- 2.NH_2^- 3.CO_3^{-2} 4.H_3O^+

11. Which of the following has no coordinate bond
1.HNO_3 2.CO 3. CH_3NC 4. CH_3CN

12. Pairs of molecules which from strongest inter molecular hydrogen bond is
1.SiH_4 and SiF_4 2. CH_3COCH_3 and $CHCl_3$

3.CH_3COOH and HCOOH 4. H_2S and H_2Se

13. Which of the following are soluble in water
1. CS_2 2. C_2H_5OH 3.CCl_4 4.$CHCl_3$

14. The boiling point of p -Nitro phenol is higher than that of O-Nitro phenol because
1. Nitro group in the p-position behaves in a different way from that O-position
2. no intramolecular hydrogen bonding exists in the case of O-Nitro phenol
3. there is inter molecular hydrogen bonding in O-Nitro phenol
4. there is inter molecular bonding in p-nitro phenol

15. Water has a boilong point of 100°C whileH_2S has a boiling point of only 42°C. This can be explained by
1. Vander waals forces 2. Covalent bonding 3. Ionic bonding 4. hydrogen bonding

16. The normal boiling point of CS_2, H_2O and CCl_4 are 41.3°C, 100°C and 77°C respectively. The liquid in which the inter molecular forces are the weakest is
1. H_2O 2.CCl_4 3. both H_2O and CS_2 4. CS_2

17. Among H_2O, H_2S, H_2Se AND H_2Te which is expected to have high boiling point? and for what reason?
1.H2O because of H-bonding 2. H2Te because of high molecular weight
2. H2S, because of H-bonding 3. H2Se, because of high molecular weight

18. Hydgrogen fluoride is liquid unlike the other hydrogen halides because
1.HF molecules associate with each other due to intermolecular hydrogen bonds
2. HF is highly reactive
3. HF is the weakes acid
4. F atom is smaller in size than bonding is found in

19. Acetic acid exists as dimer in benzene due to
1. condensation reaction 2. hydrogen bonding
3. presence of carboxyl group 4. presence of hydrogen atom at a-carbon

20. The pairs of bases in DNA are held together by
1. hydrogen bonds 2. ionic bonds
3. phosphate groups 4.deoxy ribose groups

21. The maximum posibble number of hydrogen bonds in which a water molecular can participate
1. 4 2. 3 3. 2 4.6

II. Multi correct answer type questions:

- ***This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which*** *ONE or MORE* ***is correct. Choose the correct options***

22. Which of the following gasses are not readily soluble in water
1. NO 2.CO 3.H_2O 4.CO_2

23. Which among the following does have the hydrogen bonding
1. phenol 2. Liquid NH_3 3.water 4.Liquid HCl

24. Coordinate linkage is not formed
1. by transfer of one electron from one atom to the other
2. by the loss of one electron of each from both the atom
3. by sharing of one electron from each atom 4. All the above

III. Assertion & Reasoning type:

- ***This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which*** *ONLY ONE* ***is correct Choose the correct option.***

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

25. **Statement-I:** Glycerol is more viscous than C_2H_5OH.
Statement-II: Hygrogen bonding does not occur in ethanol

26. **Statement-I:** Liquids that are hydrogen bonded have higher boiling points than non-hydrogen bonded liquids of similar molecular size and shape
Statement-II: Because hydrogen bonds are muchstronger than vander waal's forces

IV. **Matching type:**

- ***This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in*** *Column–I* ***have to be matched with statements (p, q, r, s) in*** *Column–II.* ***The answers to these questions have to be appropriately bubbled as illustrated in the following example.***
  If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:

27.

List-I	List-II
A) O-chlorophenol	1) Coodrinate colvent bond
B) Inter molecular H-bond	2) Intra molecular H-bond
C) $B_3N_3H_6$	3) Hydrated Cation
D) Dative bond	4) High boiling point

V. **Comprehension type:**

- ***This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which*** *ONLY ONE* ***is correct. Choose the correct option.***

The length of the hydrogen bond depends on the substance under investigation. It varies from $1.76^0\,A$ to $2.75^0\,A$.
The energy of hydrogen bond varies from 2 to 10 K.cals/mole.
Hydrogen bond is weaker than covalent bond and stronger than vanderwaals force of attraction.
Most electronegative atoms like Fluorine, Oxygen, Nitrogen only can involve in hydrogen bond.
Chlorine atom very rarely involves in hydrogen bond.
Hydrogen bond present in the same molecule is known as intra molecular hydrogen bond.
The intra molecular hydrogen bond is present in substances like O- Chlorophenol, O- Nitro phenol, O- Nitro aniline,

28. Intramolecular hydrogen bond is present in
1. orthohydroxy benzaldehyde 2. parahydroxy benzaldehyde
3. ethyl alcohol 4. hydrogen fluoride

29. Hydrogen bond is
1. A weak covalent bond 2. A weak electrostatic force
3. A weak metallic force 4. It is not a bond

30. Intramolecular hydrogen bonding is present in
1. meta nitrophenol 2. Salicylic acid 3. hydrogen chloride 4. benzophenone

LEARNER'S TASK

BEGINNERS (Level - I)

I. Single Answer type questions:

1. Dative bond is present in
1. Carbon monoxide 2. Carbon dioxide
3. Nitric oxide 4 Chlorine monoxide

2. Molecule having maximum number of dative bonds is
1. H_2O_2 2. NH_4^+ 3. Al_2Cl_6 4. $B_3N_3H_6$

3. The bonds present in NaCN are
1. Ionic bond 2. covalent bond
3. Co-ordinate covalent bond 4. Ionic and covalent bonds

4. In potassium ferrocyanide, the nature of bond between iron and cyanide ions is
1. Ionic Bond 2. Covalent Bond 3. Dative Bond 4. Polar Bond

5. Indicate the nature of bonding in CCl_4 and CaH_2
1. Covalent in CCl_4 and electrovalent in CaH_2
2. Electrtovalent in both CCl_4 and CaH_2
3. Covalent in both CCl_4 and CaH_2
4. Electrovalent in CCl_4 and covalent in CaH_2

6. Dative bond is not present in
1. BF_3 2. N_2O 3. BCl_3 4. $B_3N_3H_6$

7. When a cation gets hydrated, normally the bond formed between cation and water molecule is
1. Dative bond 2. Ionic bond 3. Covalent bond 4. Hydrogen bond

8. NH4CN contains
1. ionic bond 2. covalent bond 3. dative bond 4. all

9. Which of the following is a normal liquid
1. NH_3 2. H_2O 3. HF 4. Br_2

10. Among the following, the boiling point is high for
1. Ethyl alcohol 2. Dimethyl ether 3. Acetone 4. Chloroform

11. Strongest hydrogen bond is present in
1. Ammonia 2. Water 3. Hydrogen fluoride 4. Ethyl alcohol

12. Inter molecular hydrogen bond is not present in
1. Ammonia 2. Water 3. Hydrofluoric acid 4.Salicylaldehyde

13. Which of the following is miscible with water
1. CS_2 2. C_2H_5OH 3. CCl_4 4.$CHCl_3$

ACHIEVERS (Level - II)

Descriptive type questions

14. What is meant by a coordinate covalent bond? Explain by giving an example.

15. Write the conditions necessary for the formation of hydrogen bond

16. Decribe by giving suitable examples, intermplecular, intramolecular hydrogen bonding

17. BF_3 forms an adduct with NH_3 write the reason.

EXPLORERS (Level - III)

Multi correct answer type questions:

- *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which ONE or MORE is correct. Choose the correct options*

18. Dative bond is not present in the molecule
1. SO_3 2. BF_3 3. NH_3 4HF

19. Which of the following does not contains a coordinate covalent bond
1. $N_2H^+_5$ 2. $BaCl_2$ 3. HCl 4. H_2O

20. In which of the following H-bond formed is not the strongest
1.HF 2. C_2H_5OH 3.NH_3 4.H_2O

Assertion & Reasoning type:

- *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which ONLY ONE is correct Choose the correct option.*

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

21. **Statement-I:** water is one of the best solvent
Statement-II: Hydrogen bonding is present in water molecule

22. **Statement-I:** H_2O is liquid while H_2S is a gas
Statement-II: Hydrogen bonding is presenting both the cases

Matching type:

- *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in Column–I have to be matched with statements (p, q, r, s) in Column–II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*
*If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

23.

List-I	List-II
A) Inter molecular hydrogen bonding	1) Ne
B) Intra molecular hydrogen bonding	2) NaCl
C) Vander wall's forces	3) H_2O
D) Strongest bonding	4)Salicyaldehyde
	5) Iron

Comprehension type:

- *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which ONLY ONE is correct. Choose the correct option.*

Co-ordinate covalent bond is represented by an arrow $(\rightarrow)$ the head of which is close to the atom which accepts the electron pair.
The formation of co-ordinate covalent bond occurs only after the formation of covalent bonds.
Co-ordinate covalent bond is present in
Molecules like: $N_2O, O_3, H_2O_2, BF_3,$
In a hydrated cation the bond between water molecule and cation is dative bond.
Every water molecule involves in one dative bond only.
Example: $\left[Al\left(H_2O\right)_6\right]^{+++}$ ion contains 6 dative bonds.

24. The type of bonds present in ammonium chloride are
1. Only ionic and dative 2. Only covalent and electrovalent
3. Only covalent and coordinate 4. Ionic, covalent and coordinate

25. PH_3 and BF_3 form an adduct readily because they form
1. A coordinate bond 2. A covalent bond 3. An ionic bond 4. A hydrogen bond

26. Dative bond is present in the molecule of
1. NH_3 2. CO_2 3. CO 4. PCl_5

27. The bonds present in N_2O_5 are
1. Ionic 2. Covalent 3. Ionic and covalent 4. Covalent and dative

Higher Order Thinking Questions.

28. Among the following, the species that contains dative bond is
1.N_2H_5+ 2.$BaCl_2$ 3.HCl 4.H_2O

29. Which of the following molecules contain dative bond ?
1.N_2O_5 2.CO 3.O_3 4.S

30. Among the following, molecules which contain both polar and non-polar bonds are
1.NH_4Cl 2.HCN 3.H_2O_2 4.CH_4

31. The common feature among the species O_3, SO_4^{2-}, H_3O^+ is that
1.they contain only ionic bonds 2.they contain only covalent bonds
3.they contain dative bond 4.they contain covalent and ionic bonds

32. In which of the following pairs the two species are not isostructural ?
1.CO_3^{2-}, $AlCl_3$ 2.$PCl_4^+$and $SiCl_4$ 3.PF_3 and BrF_3 4.$AlF_6^{3-}$and SF_6

33. Silicon has 4 electrons in the outermost orbit. In forming the bonds,
1.It gains electrons 2. It loses electrons 3.It shares electrons 4.None

KEY

ΦΦ TEACHING TASK :

1. 4	2. 3	3. 1	4. 3	5. 4	6. 4	7. 4	8. 3	9. 3
10. 3	11. 4	12.3	13.2	14.4	15.4	16.4	17.1	18.1
19.2	20.1	21.1	22.1,2,4	23.1,2,3	24. 1,2,3		25. 3	26. 1
27. a-2,b-4,c-1,d-3			28. 1	29. 2	30. 2			

ΦΦ LEARNER'STASK :

□ **BEGINNERS :**

1. 1	2. 4	3. 4	4. 3	5. 1	6. 3	7. 1	8. 4	9. 2	10. 1
11. 3	12.4	13.2							

□ **EXPLORERS :**

18.1,3,4	19.2,3,4	20. 2,3,4	21. 2	22 3	23. a-3,b-4,c-1,d-2			24. 2	25. 1
26. 3	27.4	28.1	29.1,2	30.1	31.3	32.2	33.3		

§§ Valency shell electron pair repulsion theory (VSEPR theory)

VSEPR theory was proposed by Gillespie and Nyholm.

VSEPR theory was proposed to explain the shapes of molecules and ions.

The orbital which contains the bonded pair of electrons is known as the localised orbital.

The atom common in all bonds is known as the central atom.

i) The lone pairs of electrons and bonded pairs of electrons on central atom are oriented in such a way, that there is least repulsion between them.

ii) The repulsion between electron pairs on central atom follows the order.

l.p – l.p > l.P – b.p > b.p – b.p

iii) In VSEPR theory the number of electron pairs in single bond (or) double bond (or) triple bond (or) dative bond is counted as only one pair because all the electron pairs in the same bond are oriented in the same direction.

iv) The number of lone pairs of electrons (l.p) and bond pairs of electrons (b.p) on central atom determines the shape of molecule or ion.

Shape of molecule having only bond pairs

No. of bond paires	Shape	Molecule
2	Linear	BeF_2, $BeCl_2$, CO_2 etc
3	Triangular	BF_3, BCl_3, SO_3, CO_3^{2-} etc
4	Tetrahedral	CH_4, CCl_4 etc
5	Trigonal bipyramidal	PF_5, PCl_5 etc
6	Octahedral	SF_6, SiF_6^{-2}
7	Pentagonal bipyramidal	IF_7

Shape of molecule having bond pairs as well as lone pair electrons.

No. of bond pairs	No. of lone pairs	Total No.	Shape of Molecule		Example
			basic shape	actual shape	
2	1	3	Triangular	Angular	$SnCl_2$, SO_2
3	1	4	Tetrahedral	Pyramidal	NH_3, H_3O^+
2	2	4	Tetrahedral	Angular	H_2O
4	1	5	Folded square	See Saw	SF_4
3	2	5	Trigonal bipyramidal	T-shaped	ClF_3
2	3	5	Trigonal bipyramidal	Linear	XeF_2
5	1	6	Octahedral	Square pyramidal	IF_5, BrF_5
4	2	6	Octahedral	Square planar	XeF_4
6	1	7	Pentagonal bipyramidal	Distored octahedral	XeF_6

§§ Valency Bond Theory (V.B.T)

V.B.T was proposed by Heitler and London to explain the shapes of covalent molecules, their bond angles and bond lengths.

V.B.T was extended by pauling and slater to explain the directional nature.

i) Covalent bond is formed by the overlapping of two orbitals having unpaired electrons.

ii) The two orbitals involving in overlapping must belong to two different atoms and the electrons present in them must have opposite spins.

iii) Dative bond is formed by the overlapping of an orbital having a pair of electrons and a vacant orbital.

iv) The greater the extent of overlapping, the stronger is the bond formed.
v) The overlapping of atomic orbitals follows the order. p-p >s-p > s-s
vi) A covalent bond formed with its electron cloud concentrated along the inter nuclear axis and having a cylindrical symmetry is known as sigma bond (σ).

Linear overlapping of atomic orbitals results in the formation of sigma bond (σ).

A covalent bond formed by the side wise overlap of atomic orbitals of atoms already bonded through a 'σ' bond and in which the electron cloud is present on either side of the inter nuclear axis is known as a pi bond (π).

Lateral overlapping of atomic orbitals results in the formation of pi bond (π).

'π' bond is formed only after the formation of 'σ' bond.
Any type of orbitals can involve in 'σ' bond formation.
Only 'p' or 'd' - orbitals can involve in 'π' bond information.
Single bond is equal to one 'σ' bond.
Double bond is a combination of one 'σ' bond and one 'π' bond.
Triple bond is a combination of one 'σ' bond and two 'π' bonds.
σ bond is stronger than 'π' bond.
Strength of the bonds follows the order

$$\sigma_{p-p} > \sigma_{s-p} > \sigma_{s-s} > \pi$$

Strength of the bonds follows the order
triple bond > double bond > single bond.

§§ **Bond angles:**

The internal angle between the lines joining the centre of the nucleus ofone atom to the centres of the nucleii of two other atoms combined to it is known as bond angle.
The bond angles are measured with methods like X-ray diffraction,electrondiffraction
The bond angle is 180^0 in $BeF_2, BeCl_2,\ CO_2, CS_2, XeF_2, ZnCl_2, HgCl_2, HCN, N_2O, C_2H_2, I_3^- ion$.
The bond angle is 120^0 in $BF_3, BCl_3, SO_3, CH_2O, C_2H_4$
The bond angle is 109^028^1 in $CH_4, CCl_4, SiH_4, SiCl_4, NH_4^+$
The bond angle is 90^0 XeF_4, BrF_5, SF_6
Bond angles are 90^0 and 180^0 in ClF_3, BrF_3, ICl_3
Bond angles are 90^0 and 120^0 in $PCl_5, AsCl_5, SbCl_5$
The bond angles in

NH_3, H_3^+O		107^0
H_2O	–	104^030^1
NF_3	–	102^030^1
OF_2	–	102^0
Cl_2O	–	111^0

TEACHING TASK

I. Single Answer type questions:

1. Linear molecule among the following is
1. H_2S 2. Cl_2O 3. XeF_2 4.ClO_2

2. The central atom in IF_7 has seven pairs of valency electrons. The shape of the molecule as per VSEPR theory is
1. Trigonal bipyramid 2. hexagonal pyramid `

3. pentagonal bipyramid 4. Square bipyramid

3. The shape of formaldehyde molecule as per the VSEPR theory is
1. Linear 2. Planar triangle 3. Pyramid 4. Tetrahedron

4. Shape of hydronium ion is
1. Tetrahedron 2. Square planar 3. Planar triangle 4. Pyramid

5. Which of the following molecule does not have a linear arrangement of atoms
1. H_2S 2. C_2H_2 3. BeH_2 4. CO_2

6. CO_2 is not iso-structural with
1. $HgCl_2$ 2. $SnCl_2$ 3. C_2H_2 4. $ZnCl_2$

7. Shape of phosphorus pentachloride molecule is
1. Octahedron 2. Square pyramid 3.Trigonal bipyramid 4. Pyramid

8. Which of the following has distorted tetrahedron shape
1. SiH_4 2. CCl_4 3. H_2O 4. $CHCl_3$

9. The shape of Ammonium ion is
1. Tetrahedron 2. Pyramid 3. Square planar 4. Square pyramid

10. Which of the following is not a pyramidal species
1. NH_3 2. H_3^+O 3. PH_3 4. NH_4^+

11. Of the following species, the one having planar structure is
1. NH_4^+ 2. BF_4^- 3. XeF_4 4. CCl_4

II. Multi correct answer type questions:

◆ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which ONE or MORE is correct. Choose the correct options*

12. AB_3 type molecule contained one lone pair of electron. It dosen't have a structre as per VESPR theory
1. pyramidal 2. tetrahedral 3.V-shaped 4. Linear

13. In a molecule ,central atom has 7 bonded pairs the true about the molecule is
1. pentagonal bipyramidal 2. sp^3d^3
3. two unequal bond angles 4. octahedral

14. Incorrect order of repulsive interactions among the following are
1. l.p-l.p> l.p-b.p>b.p-b.p 2. b.p-b.p> l.p-l.p>l.p-b.p
3. l.p-b.p> b.p-b.p>b.p-l.p 4.b.p-l.p> l.p-b.p>l.p-l.p

15. Which of the following molecule does have a linear arrangement of atoms
1. C_2H_2 2.H_2O 3. $BeCl_2$ 4. CO_2

III. Assertion & Reasoning type:

◆ *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which ONLY ONE is correct Choose the correct option.*

1. Statement-I, Statement-II are true but Statement-II doesn't explain 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

16. **Statement I:** A multiple bond can be treated as one bond.
Statement II : Between 2 atoms, not more than three bonds present.

17. **Statement I:** The bond angle in PBr_3 is greater than PH_3 but the bond angle in NBr_3 is less than that of NH_3
Statement II: Size of bromine is less than hydrogen

18. **Statement I:** In NH_3, the H-N-H bond angle is $107^0 18'$ instead expected value $109^0 28'$

Statement II: The l.p-b.p repulsion is greater than the b.p-b.p repulsion

IV. Matching type:

◆ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in Column–I have to be matched with statements (p, q, r, s) in Column–II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*
*If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

19.

Column-I	**Column-II**
a) NH_3	1) 4 bond pairs and no lone pairs on the central atom
b) H_2O	2) 2 bond pairs and 2 lone pairs
c) O_2	3) 3 bond pairs and 1 lone pair
d) CCl_4	4) 2 bond pairs and 4 lone pairs

20.

Column-I	**Column-II**
a) Pyramidal	1) SO_3
b) Octahedral	2) BeH_2
c) Linear	3) ClO_3^-
d) Triangular	4) CCl_4
	5) SF_6

21.

Column-I	**Column-II**
a) BF_4^-	1) Central atoms is SP^3d hybridised
b) Resonance energy	2) HCl
c) $\mu > o$	3) Stability of molecule
d) I_3^-	4) Isostructure with CH_4
	5) Plannar structure

V. Comprehension type:

◆ *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which ONLY ONE is correct. Choose the correct option.*

During chemical bond formation the potential energy of the bonding atoms decreases. According to VBT bond strength depends on extent of over lapping .Shapes and bond angles of the molecules were explained by VSEPR theory.This theory explains the Geometry of the molecules based on the repulsions among the valance shell electron pairs. As number of lone pairs increases repulsions increases and the shape is altered accordingly.

22. Molecule, which involves p-p overlapping, is
a) H_2 b) HCl c) Cl_2 d)NH_3

23. Which of the following is correct with respect to SO_2 molecule
1. AB_2E_2 type, trigonal planer shape 2. AB_2E type , Bent shape
3. AB_3 type, bent shape 4. AB_3E type, square planar

24. AB_4E_2 type of molecule with square planar shape is
1. ClF_3 2. SF_4 3. H_2O 4 XeF_4

25. Which of the following shows maximum bond angle
1. CH_4 2. NH_3 3. H_2O 4. BeF_2

26. Orientation of electron pairs in ClF_3 molecule is like
1. T - Shaped 2. Trigonal bi pyramidal
3. Tetrahedral 4. Octahedral

LEARNER'S TASK

BEGINNERS (Level - I)

I. Single Answer type questions:

1. The orbital overlapping is maximum in
1. Cl_2 2. H_2 3. HCl 4. HBr

2. The molecule having maximum number of sigma bonds in it is
1. Ethane 2. Ethene 3. Ethyne 4.Sulphur hexafluoride

3. The number of sigma and Pi bonds in a molecule of cyanogen are
1. 4,3 2. 3,4 3. 5,2 4. 3,5

4. Linear combination of two hybridised orbitals belonging to two atoms and each having one electron leads to a
1. Sigma bond 2. Double bond 3. Co-ordinate covalent bond 4. pi bond

5. s - p overlapping is present in
1. Br_2 2. H_2 3. O_2 4. HF

6. Molecule which contains only sigma bonds in it is
1. Pentene 2. Pentane 3. Pentadiene 4. Pentyne

7. Which one of the following is an incorrect statement
1. A pi bond is formed when a sigma already exists
2. A pi bond may be formed by the overlapping of 'p' or 'd' orbitals
3. A pi bond is formed by the overlapping of hybrid orbitals
4. A pi bond is formed by the lateral overlapping of atomic orbitals

8. pi bond is formed by the overlapping of
1. p - p orbitals along their axis
2. s - p orbitals along the axis of p - orbital
3. p - p orbitals perpendicular to their axis
4. s - s orbitals

9. Which of the following is not correct
1. A sigma bond is weaker than pi bond
2. A sigma bond is stronger than pi bond
3. A double bond is stronger than a single bond
4. A double bond between two atoms is shorter than a single bond between same atoms.

ACHIEVERS (Level - II)

Descriptive type questions

10. Arrange the following according to the increasing bond angles in them:NH_3,H_2O&CH_4

11. What are the approxmate bond angles in the following: NO^-_3, SiF_4, PH_3,

12. Explain why is BeF_2 a linear while SF_2 an angular molecule?

13. Do NH_3 and BF_3 have the same shape?Give reason

14. Why is the shape of H2O molecule angular (bent) or V-shaped?

15. Write the diffrences between sigma and pi bond.

LEVEL-II

Multi correct answer type questions:

- *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which ONE or MORE is correct. Choose the correct options*

16. A molecule with four bonded electron pairs on the central atom & no lone pair is likely to have
1. sp^3 2. tetrahedral 3. 109^028^1 4. triangular planar

17. Three lone pairs of electrons are absent in

1. H_2O 2. HF 3. NH_3 4. CH_4

18. Which of the following does have lonepair of electrons

1. HCl 2. HOH 3. NH_3 4. NH_4^+

19. Which of the following will have same shape

1. PCl_3 2. NH_3 3. PH_3 4. BF_3

Assertion & Reasoning type:

◆ *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which ONLY ONE is correct Choose the correct option.*

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

20. **Statement I:** H–O–H bond angle in H_2O is $104^0\ 5^l$ and not $109^0 28^l$.

Statement II : L.P – L. P and L.P – B.P. repulsions are responsible for the distortion in bond angle of H_2O molecule.

21. **Statement I:** In NH_3, N is sp^3 hybridised, but angle is found to be 107^0

Statement II: The decrease in bond angle is due to repulsion between the lone pair on nitrogen and bond pair between N & H.

22. **Statement I:** Bond angle of H_2S is greater than H_2O.

Statement II: Electronegativity of central atom decrease, bond angle decreases

23. **Statement I:** ClF_3 molecule is isoelectronic with SF_4 but its geometry is T-shaped

Statement I: 5 electron pairs present in ClF_3 in total consist of 2 lonepairs & 3 bondpairs

Matching type:

◆ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in Column–I have to be matched with statements (p, q, r, s) in Column–II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

*If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

24.

Column-I	Column-II
a) CH_4	1) 120°
b) NH_3	2) 104.5°
c) H_2O	3) 107°
d) BF_3	4) 109°28’

25.

Column-I	Column-II
a) NH_4^+	1) Tetrahedral
b) H_2O	2) Angular
c) SeF_6	3) Linear
d) $BeCl_2$	4) Octahedral

26.

Column-I	Column-II
a) PCl_5	1) Linear
b) NH_3	2) Triangular

c) BCl_3 3) Pyramidal

d) CO_2 4) Trigonal bipyramidal

Comprehension type:

◆ *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which ONLY ONE is correct. Choose the correct option.*

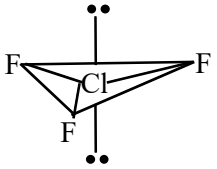
Valence shell electron pair repulsion theory (VSEPR) is used to predict the shapes of simple molecules. The shape of a molecule will depend on the repulsions between the valence shell electron pairs around the central atom of a molecule. The molecule will adjust in such a way that the repulsions between these electron pairs is minimum. The repulsion order between the electron pairs will be $bp-bp < bp-lp < lp-lp$.

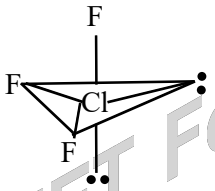
The magnitude of repulsions between the electron pairs also depends on the difference in electronegativity of the central atom and other atom.

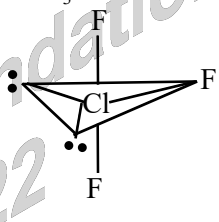
27. The expected bond angle in H_2O and F_2O are respectively.

1. $104^0 30^1 \& 103^0$ 2. $104^0 30^1 \& 120^0$ 3. $120^0 \& 104^0 30^1$ 4. $104^0 30^1 \& 107^0$

28. Among the following the correct representation of ClF_3.

1. 

2. 

3. 

4.All the above

29. Identify the set with zero dipole moment

1. $AlCl_3, PCl_3$ 2. Orthodichloro benzene, para dichloro benzene

3. BF_4^-, NH_4^+ 4. CS_2, CSO

Higher Order Thinking Questions.

30. Among the following, the molecules formed by s-p overlaping is

1.HF 2.N_2 3.F_2 4.Cl_2

31. The molecule formed by p-p overlaping are

1.Br_2 2.H_2 3.N_2 4.I_2

32. Which of the following type of bonds are present in HCN molecules

1.Sigma and pi 2. σ sp-s 3. σ sp-p 4. π p-p

33. The angle between two covlent bonds is minimum in

1.H_2O 2.CO_2 3.NH_3 4.CH_4

34. The shape of AB_3E is

1.pyramidal 2.Tetrahedral 3.Angular 4.Liner

35. The pair having similar geometry is

1.BF_3, NH_3 2.H_2O,C_2H_2 3.CO_2,SO_2 4.NH_3,PH_3

KEY

ΦΦ TEACHING TASK :

1. 3	2. 3	3. 2	4. 4	5. 1	6. 2	7. 3	8. 3	9. 1	10. 4
11. 3	12.2,3,4	13.1,2,3,	14.2,3,4	15.1,3,4	16. 2	17. 3	18.2		
19. a-3,b-2,c-4,d-1			20. a-3,b-5,c-2,d-1			21. a-4,b-3,c-2,d-1			
22. 3	23. 2	24. 4	25.4	26.1					

ΦΦ LEARNER'STASK :

☐ **BEGINNERS :**

1. 1 2. 1 3. 2 4. 1 5. 4 6. 2 7. 3 8. 3 9. 1

☐ **EXPLORERS :**

16.1,2,3, 17.1,3,4 18.1,2,3 19.1,2,3 20.1 21.1 22.4 23.1 24.a-4,b-3,c-2,d-1
25. a-1,b-2,c-4,d-3 26. a-4,b-3,c-2,d-2 27. 1 28. 3 29. 4 30.1 31.1,3,4
32.1 33.1 34.1 35.4

§§ **Hybridisation:**

The concept of hybridisation was introduced by pauling.

The inter mixing of atomic orbitals of almost same energy and their redistribution into an equal number of identical orbitals is known as hybridisation.

i) The orbitals of one and the same atom only involve in hybridisation.
ii) The orbitals involving in the hybridisation have different shapes but almost same energy.
iii) The orbitals formed in hybridisation process are called hybrid orbitals and they have same shape and same energy.
iv) The angle between any two hybrid orbitals in an atom is generally same.
v) Electron filling in hybrid orbitals obeys Hunds rule & Pauli's rule
vi) The hybrid orbitals involve only in 'σ' bond formation.
vii) The concept of hybridisation was introduced to explain the
shapes of molecules.
bond angles in the molecules
bond lengths in the molecules.

§§ **SP - hybridisation:**

This is also known as digonal hybridisation (or) linear hybridisation.

One s-orbital combines with one P- orbital and gives two identical orbitals called SP - hybrid orbitals.

The angle between the two SP-hybrid orbitals in an atom is 180^0

sp-hybrid orbital will have
1/2 s-character (or) 50% S- character.
1/2 p-character (or) 50% P- character.

The hybridisation of central atom in a linear molecule is generally sp.

§§ **SP^2 - hybridisation:**

This is also known as trigonal hybridisation.

One S- orbital combines with two-P-orbitals and gives three identical orbitals called SP^2 - hybrid orbitals.

The angle between any two SP^2 -hybrid orbitals in an atom is 120^0.

SP^2 hybrid orbital will have
1/3 rd S- character (or) 33.3% S-character.
2/3 rd P- character (or) 66.7% P-character.

The hybridisation of central atom in a molecule having planar triangle shape is SP^2.

§§ **SP^3 - hybridisation:**

This is also known as tetrahedral hybridisation (or) tetragonal hybridisation.

One s-orbital combines with three P-orbitals and gives four identical orbitals called SP^3 hybrid orbitals.

The angle between any two SP^3 -hybrid orbitals in an atom is $109^0.28^1$.

SP^3 - hybrid orbital will have

1/4 th S- character (or) 25% S- character.

3/4 th P- character (or) 75% P- character.

The hybridisation of central atom in a molecule having tetrahedral shape is SP^3.

§§ **SP^3d - hybridisation:**

One S-orbital, three P-orbitals and one d-orbital combines and gives five identical orbitals called SP^3d -hybrid orbitals.

The angle between two SP^3d hybrid orbitals in an atom is 90^0 or 120^0.

hybrid orbital will have

1/5 th S-character (or) 20% S-character.

3/5 th P-character (or) 60% P-character.

1/5 th d-character (or) 20% S-character.

The hybridisation of central atom in a molecule having trigonal bipyramid shape is SP^3d.

§§ **SP^3d^2 - hybridisation:**

One S-orbital , three P-orbitals and two d- orbitals combines and gives six identical orbitals called SP^3d^2 hybrid orbitals.

The angle between any two SP^3d^2 hybrid orbitals in an atom is 90^0.

SP^3d^2 hybrid orbital will have

1/6th s-character (or) 16.7% S- character.

¶¶ **Assigning the type of hybridisation:**

1) Total molecular valency method

Step 1: Totoal number of valence electron in the molecule is calculated adding the individual valency of all constituent atoms.

Step 2: If ttal electrons are greater than eight then divided by eight and quotient is equal to hubridised orbitals. E.g: PCl_5

Total valence electrons = 5 + (5 × 7) = 40

40/8 = 5 = no. of hybridised orbitals –>sp^3d

If remainder comes, that remainder should be divided by 2, still remainder is equal to number of hybridised orbitals. E.g: $XeOF_2$

Total valence electrons = 8 + 6 + (2 × 7) = 28

28 / 8 Quotient = 3

Remainder = 4

Remainder is divided by 2

4/2 quotient = 2

Hence, sum of Quotient = 3 + 2 = 5 = no. of hybridised orbitals –>sp^3d

Step 3: If total valence electrons is either eight or less, dividing by 2, what quotient appears should be considered as number of hybridised orbitals. E.g: H_2O

Total valence electrons = 2 + 6 = 8

§§ **Hybridisation in Carbon Compounds**

The carbon atom in carbon compounds is tetravalent (i.e., carbon atoms forms four covalent bonds).

The SP^3 carbon atom involves in four single bonds $-\overset{|}{C}-$

The SP^2 carbon atom involves in a double bond and two single bonds. $=\overset{|}{C}-$

The SP carbon atom involves in two double bonds (or) one triple bond and one single bond $=C=$ or $\equiv C-$

TEACHING TASK

I. Single Answer type questions:

1. The acetylene molecule has total of
1. Two sigma bonds and two pi bonds 2. Three sigma bonds and three pi bonds
3. Three sigma bonds and two pi bonds 4. four sigma bonds and one pi bond

2. Which among the following has a pyramidal shape
1. H_2O 2.SF_6 3.CH_4 4.NH_3

3. The total number of Sp2 hybridised orbitals in ethylene molecule is
1. 2 2. 4 3. 6 4. 8

4. An example of a non linear molecule
1. H_2S 2. CO_2 3. C_2H_2 4.N_2

5. The species in which the central atom uses sp^2 hybrid orbital in its bonding is
1. PH_3 2.NH_3 3. CH_3^+ 4.SbH_3

6. The compound in which C used its sp^3 hybrid orbitals for bond formation is
1. HCOOH 2. $(NH_2)_2CO$ 3. $(CH_3)_3COH$ 4.CH_3CHO

7. H-C-H bond angle in methane is
1. 120^0 2. 180^0 3.107^018 4.109^028

8. The type of hybridisation of orbitals employed in the fomration of SF_6 molecule is
1. sp^3d 2.sp^2d^2 3. sp^3d^3 4. sp^3d^2

9. Which of the following has gratest angle between the two covalent bonds
1.CO_2 2.CH_4 3. NH_3 4. H_2O

10. The type of hybride orbitals used by chlorine atom in ClO_2^-
1. sp 2.sp^2 3.sp^3 4. dsp^2

11. Which of the following molecules has a tetrahedral shape
1. $HgCl_2$ 2CO_2 3.NH_4^+ 4. $Ni(CN)_4^{-2}$

12. Hybridizations of carbon atoms participated in the C-C single bond of the molecule $CH\equiv C\text{-}CH=CH_2$ is
1. sp^3,sp^3 2. sp^2,sp^2 3. sp-sp^2 4.sp^2-sp^3

13. Which of the following pairs represent correct infromation
1. $BeCl_2$, linear 2. NH_3, triangular 3. CO_2, angular 4. BF_3, pyramidal

II. Multi correct answer type questions:

◆ *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which ONE or MORE is correct. Choose the correct options*

14. Which of the following is true for sp^3 hybridisation?
1. One 's' orbital merges with three 'p' orbitals to form one sp^3 hybridised orbital.
2. It is also called tetrahedral hybridisation.
3) After hybridisation, sp^3 hybridised orbitals orient tetrahedrally in the space.
4) CH_4, H_2O, NH_3 and diamond are the examples of the molecule containing sp^3

15. Which among the following molecule is planar
1. C_6H_6 2. C_2H_4 3. SO_3 ` 4. C_2H_6

16. Which is not correct statement about N & B atoms in a 1:1 complex of BF_3 & NH_3
1. N : tetrahedral,sp^3;B :tetrahedral,sp^3 2. N : pyramidal,sp^3; B : pyramidal,sp^3
3. N : pyramidal,sp^3;B :planar,sp^2 4. N: pyramidal,sp^3; B :tetrahedral,sp^3

17. Which is correct statement about Xe in XeF_4
1. Involves sp^3d^2 hybridisation 2. Its geometry is octahedral

3. it is isostructural with SF_6 4. invoves trigonal bipyramidals

III. Assertion & Reasoning type:

◆ *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which ONLY ONE is correct Choose the correct option.*

1) Statement-I, Statement-II both are true and Statement-II explain Statement-I.
2) Statement-I, Statement-II both are true but Statement-II doesn't explain Statement-I.
3) Statement-I is true, Statement-II is false.
4) Statement-I is false, Statement-II is true

18. **Statement I:** In ammonia the bond angle is 107^0
Statement II: In ammonia nitrogen assumes sp^3 hybridisation

19. **Statement I:**The hybridization prossessed by oxygen atom in OF_2 molecule is SP^2
Statement II: SP^2 hybrid structure have trigonal planner geometry.

20. **Statement I:** XeF_2 molecule does not obey octet
Statement II: Xe atom in XeF_2 assume sp hybriised state.

21. **Statement I:** I_3^- is linear
Statement II: It is not in sp hybridized state

IV. Matching type:

◆ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in Column–I have to be matched with statements (p, q, r, s) in Column–II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

*If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

22.

Column-I	**Column-II**
a) sp^2	1) SF_6
b) sp^3	2) PCl_5
c) sp^3d	3) CCl_4
d) sp^3d^2	4) SO_2
	5) CO_2

23.

Column-I	**Column-II**
a) CH_4	1) sp
b) C_2H_2	2) sp^2
c) C_6H_6	3) sp^3
d) SF_6	4) sp^3d
	5) sp^3d^2

24.

Column-I Type of hybridization	**Column-II** Bond angles and examples
a) sp	1) 180°
b) sp^2	2) 120°
c) sp^3	3) $109°28^1$
d) 50% s - character	4) sp
	5) CH_4, CCl_4

V. Comprehension type:

The characteristic geometrical shapes of poly atomic molecule can be explained by the concept of hybridization of atomic orbitals. Diagonal hybridization involves one S and one P Orbitals. Name of hybrid orbital is assigned based on the pure. Orbitals involved is hybridization . The shape of the molecule is determined by the so called sigma frame work and the Pi bond only modify the dimensions of the molecules.

25. Trigonal planar hybridization is observed in
1. C_2H_2 2. CO_2 3. C_2H_4 4. H_2O

26. The bond angle of the molecules which shows tetrahedral hybridization
1. 120^0 2. 180^0 3. $109^028'$ 4. 90^0

27. The Orientation of valance shell electron pairs and shape of the NH_3 molecule is
1. Trigonal Planar, Linear 2. Pyramidal, Linear
3. Tetrahedral, Pyramidal 4. Linear,Tetrahedral

LEARNER'S TASK

BEGINNERS (Level - I)

I. Single Answer type questions:

1. The s - character in the hybrid orbital of the central atom, present in a moleculehaving the shape of an octahedron is
1. 25% 2. 75% 3. 40% 4. 16.66%

2. The hybridisation of Nitrogen in Nitrate ion is
1. sp 2. sp^2 3. sp^3 4. sp^3d

3. Hybridisation of iodine in iodine hepta fluoride molecule is
1. sp^3d^3 2. sp^3d 3. sp^3d^2 4. dsp^2

4. The molecule which contains sp^3d^2 and p orbitals overlapping in it is
1. PCl_5 2. BrF_5 3. ClF_3 4. IF_7

5. In which of the following molecule, the central atom is not sp^3d hybridised
1. PCl_5 2. ClF_3 3.SeF_6 4.XeF_2

6. The type of hybrid orbitals used by the oxygen atom in Cl_2O molecule is
1. sp^3 2. sp^2 3. sp 4. None

7. Bond angle between two hybrid orbitals is 107°, s - orbital character of hybrid orbital is nearly
1. 50 % 2.33.33% 3. 16.6 % 4. 25 %

8. Molecule obtained by sp^3d^2 hybridisation has bond angle of
1. 90° 2. 109°28' 3. 120° 4. 180°

9. Hybridisation of oxygen in hydronium ion is
1. sp 2.sp^2 3.sp^3 4. None

10. The hybrid orbital with maximum s - character is
1. sp^2 2. sp 3. sp^3 4. sp^3d

11. The hybrid orbital having equal amounts of s and p - characters is
1. sp 2. sp^3 3. sp^2 4. sp^3d

12. Hybrid orbital with least s - character is
1. sp^3d 2. sp^2 3. sp^3 4. sp

13. Hybrid orbital having maximum p - character is
1. sp^3d 2. sp^3 3. sp 4. sp^3d^2

14. The hybridisationof Bromine in BrF_5 molecule is

1. sp^3d 2. sp^3d^3 3. sp^3 4. sp^3d^2

15. The hybridisation of carbon in carbon dioxide molecule is
1. sp^2 2. sp 3. sp^3 4. None

16. The hybridisation of central atom is not sp^3d in
1. PCl_5 2. BrF_3 3. XeF_2 4. BrF_5

17. Molecule having sp^2 hybrid atom in it is
1. $BeCl_2$ 2. CO_2 3. HCHO 4. NH_3

18. A sp^3 hybrid orbital contains
1. 1/4 th s - character 2. 1/2 th s - character
3. 2/3 th s - character 4. 3/4 th s - character

19. Beryllium atom in beryllium fluoride is
1. sp^3 hybridised 2. sp^2 hybridised 3. sp hybridised 4. Unhybridised

20. Hybridisation in SO_2 molecule is
1. sp 2. sp^2 3. sp^3 4. sp^3d

ACHIEVERS (Level - II)

Descriptive type questions

21. What is the percentage of "s" character in sp,sp^2,sp^3 hybrid orbitals?

22. What type of hybridisation is shown by the central atomin each of the following?
a) NO_3^- b) H_2O c)PCl_5

23. Explain hybridisation in SF_6 molecule?

24. Write the state of hybridisation of P in PF_5, & that of S in SF_4?

EXPLORERS (Level - III)

Multi correct answer type questions:

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D),out of which ONE or MORE is correct. Choose the correct options

25. sp^3d hybridization having
1.1/5 s-character 2.1/5 d-character 3.d-character 4. s-character

26. Which of the following molecules is/are not linear?
1. CO_2 2. NO_2 3. SO_2 4. ClO_2

27. The type of hybridisation absent with two unequal bond angles
1. sp^3 2. sp^2 3. sp^3d^2 4. sp^3d

28. Which molecule is not T- shaped
1. BeF_2 2. BCl_3 3. NH_3 4. ClF_3

29. Which of the following is tetrahedral
1. BF_4^- 2. NH_4^+ 3. SO_4^{-2} 4. CO_3^{-2}

30. In which of the following compounds the carbon does not undergoes only sp^3
1. propene 2. acetylene 3. 2 - butene 4. ter. butyl alcohol

31. Pick out the isoelectronic structures from the following
1. CH_3^+ 2. H_3O^+ 3. NH_3 4. CH_3^-

32. Which of the following statements is not true for ammonium ion
1. all bonds are ionic 2. all bonds are covalent
3. H- atoms are situated at the corners of a square
4. H- atoms are situated at the corners of a tetrahedron

Assertion & Reasoning type:

This section contains certain number of questions. Each question contains Statement – 1(Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which ONLY ONE is correct Choose the correct option.

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.

33. **Statement-I :** Shape of NH_3 molecule is terahedral.
Statement-II : In NH_3 nitrogen is sp^3 hybridised.

34. **Statement-I :** Geometry of SF_4 molecule can be termed as distorted terahedron, or see saw
Statement-II : Four fluorine atoms surround or form bond with sulphur molecule

35. **Statement-I :** ClF_3 molecule is isoelectronic with SF_4 but its geometry is T-shaped.
Statement-II : Five electron pairs present in ClF_3 in total consist of two lone pairs and three bond pairs

Matching type:

◆ *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in Column–I have to be matched with statements (p, q, r, s) in Column–II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

*If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

36.

Column-I	**Column-II**
a) Trigonal bi pyramidal	1) 105º
b) Linear	2) 180º
c) V shape	3) 72º
d) Octahedral	4) 90º
	5) 120º

37.

Column-I	**Column-II**
a) $BeCl_2$	1) sp^2
b) BCl_3	2) sp^3d
c) SF_6	3) sp^3d^2
d) PCl_5	4) sp^3
	5) SP

38.

Column-I	**Column-II**
a) Pyramidal	1) SO_3
b) Octahedral	2) BeH_2
c) Linear	3) SF_6
d) Triangular	4) ClO_3^-
	5) CCl_4

Comprehension type:

◆ *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which ONLY ONE is correct. Choose the correct option.*

Total number of electron pairs = $\frac{1}{2}$ (number of valence electrons ± electrons (for ionic charge)

2.Number of bond electron pairs = number of atoms – 1

3.Number of electron pairs around central atom = total number of electron pairs – 3 [number atoms (except H)]

4.Number lone pair = (number of central electron pairs – number bond pairs)

39. Pair of species with same shape and same state of hybridisation of the central atom is:

1. PCl_5, ICl_4^- 2. NH_3, H_2O 3. NH_3, ClO_3^- 4. ICl_4^-, ClO_3^-

40. Square planar shape is predicted for:

1. ICl_4^-, ClO_3^- 2. PCl_4^+, PCl_6^- 3. ICl_4^-, PCl_4^+ 4. ICl_4^-, XeF_4]

41. Based on above method, structure of the some of the molecules have been matched. Which is the incorrect matching?

1. PCl_5 - trigonal bipyramidal 2. ClO_3^- - square planar

3. ICl_4^- - square planar 4. PCl_4^+ - tetrahedral

Higher Order Thinking Questions.

42. Hybridisation of chromium in the complex $[Cr(NH_3)_4Cl_2]$ Br is

1.sp^3 2. sp^2 3.dsp^3 4.d^2sp^3

43. The hybrid state of B in BF_4^- is

1. sp 2. sp^2 3. sp^3 4. sp^3d

44. Hybridisation state of iodine in ICl_2^+ is

1. dsp^2 2. sp 3. sp^2 4. sp^3

45 . Which one of the following is a correct set ?

1.H_2O,sp^3,angular 2.H_2O,SP^2, liner

3.NH_4+,dsp^2,squre planar 4.CH_4,dsp^2,tetrahedral

46. Which one of the following has a pyramidal shape

1.XeF_4 2.XeO_3 3.XeF_2 4.XeF_6

47. In which one of the following molecules, sigma bonds formed by the overlap of sp^3d and p-orbitals are absent

1.PCl_5 2.ClF_3 3.$SbCl_5$ 4.$HClO_4$

RESEARCHERS (Level - IV)

1. The molecule that deviated from octet rule is **(EAMCET 95M)**

1. NaCl 2. $BeCl_2$ 3. MgO 4. NH_3

2. The number of sigma bonds in ethane formed by the overlap of sp^3 and s orbitals is **(EAMCET 99M)**

1. 5 2. 6 3. 7 4. 4

3. The hydrogen bond is strongest in **(IIT 2004)**

1. O-H...O 2. S-H....S 3.F-H....F 4. F-H...O

4. The structure of ICl_2^- **(Pb set 98)**

1. trigonal 2. trigonal by pyramidal 3. linear 4. square plannar

5. The compound which has maximum number of lone pairs on central atom **(IIT2005)**

1.$[ClO_3]^-$ 2. XeF_4 3. SF_4 4.I_3^-

6. Bond angle of $109^o\ 28^I$ is found in **(AIEEE 2002)**

1. NH_3 2.H_2O 3.CH_3^+ 4. NH_4^+

7. The correct order of hybridzation of the central atom in the following species NH_3 $[PtCl_4]^{-2}$, PCl_5 and BCl_3 is **(IIT 2001)**

1. dsp^2,dsp^3,sp^2,sp^3 2.sp^3,dsp^2,dsp^3,sp^2

3. dsp^3,sp^2,sp^3,dsp^2 4. sp,dsp^3,sp^2,sp^3

8. Using VSEPR theory, draw the shapes of PCl_5 and BrF_5 **(IIT 2003)**

9. Based on VSEPR theory the number of 90^o F-Br-F angles in BrF_5 is **(IIT 2010)**

10. What is the angle between two sp, sp2 & sp3 hydridorbitals **(IIT 2008)**

II. Additional practice sheet:

1. The charge on a cation 'M' is $^{+2}$ and anion 'A' is $^{-3}$ The compound formed has the formula
1.MA_2 2.M_3A_2 3.M_2A_3 4.M_2A

2. Two elements 'X' and 'Y' have the following configuration
X=$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2$ & Y=$1s^2\,2s^2\,2p^6\,3s^2\,3p^5$ The compound formed by the combination of 'X' and Y will be
1.XY_2 2.X_5Y_2 3.X_2Y_5 4.XY_5

3. An element X is a strogly electropositive and an element Y strongly electronegative and both are univalent. The compound formed would be
1.X^+Y^- 2.X^-Y^+ 3.X-Y 4.$X \rightarrow Y$

4. The type of hybridisation present on S in SO_2 and SO_3 molecules respectively
1.sp,sp^2 2.sp^2,sp^2 3.sp,sp^3 4.sp^2,sp^3

5. The molecule with maximum number of lone pairs on central atom is
1.XeO_3 2.SF_4 3.PCl_3 4.ICl

6. The shape of PO_4^{3-} ion is
1.sqare planar 2. tetrahedral 3.Trigonal bipyramidal 4. Hexagonal

7. Statement I: In SF_4 molecule S does not obey octet rule.
Statement II :In PCl_3 molecule P obey octet rule.

8. Statement I: In CH_4 molecule carbon atom follows octet rule.
Statement II : Four bond pairs are present in methane molecule.

9.

	Column-I	Column-II
a)	Benzene	1) Good conductor
b)	water	2) Non polar solvent
c)	Solid NaCl	3) polar solvent
d)	Aqueous NaCl	4) Bad conductor

10.

	Column-I	Column-II
a)	Argon	1) 2s2 2p6
b)	Helium	2) 4s2 4p6
c)	Neon	3) 1s2
d)	Krypton	4) 3s2 3p6

KEY

ΦΦ TEACHING TASK :

1. 3	2. 4	3. 3	4. 1	5. 3	6. 3	7. 4	8. 4	9. 1	10. 3
11.3	12. 3	13. 1	14.1,2,3,4	15.1,2,3,		16.1, 2,4		17. 1,3	18.1
19. 4	20. 3	21. 2	22.a-4,b-3,c-2,d-1		23.a-3,b-1,c-2,d-5			24.a-1,b-2,c-3,5,d-4	
25. 3	26. 3	27. 3							

ΦΦ LEARNER'STASK :

☐ **BEGINNERS :**

1. 4	2. 2	3. 1	4. 2	5. 3	6. 1	7. 4	8. 1	9. 3
10. 2	11.1	12. 1	13. 3	14. 4	15. 2	16. 4	17. 3	18. 1
19. 3	20.2							

☐ **EXPLORERS :**

25.1,2 26.2,3,4 27.1, 2,3 28. 1,2,3 29. 1,2,3 30. 1,2,3
31. 2,3,4 32. 1, 2,3 33. 4 34. 1 35. 1
36. a-5,b-2,c-1,d-4 37. a-5,b-1,c-3,d-2 38. a-4,b-3,c-2,d-1
39. 3 40. 4 41. 2 42.4 43.3 44.4 45.1 46.2 47.1

☐ **RESEARCHERS :**

I. 1. 2 2. 2 3. 3 4. 3 5. 4 6. 4 7. 2

II. 1.2 2.1 3.2 4.2 5.4 6.2 7.2 8.1
9.a-2,b-3,-4,d-1 10.a-4,b-3,-1,d-2