CHEMICAL BOND

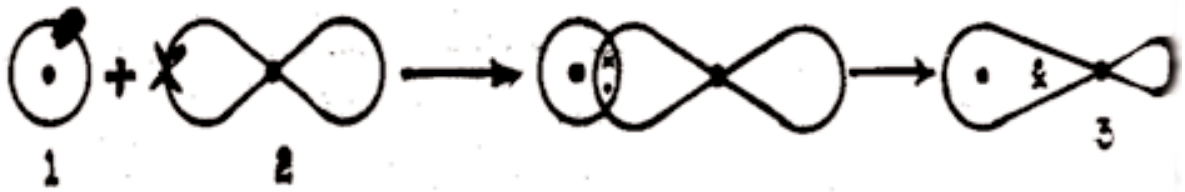
PART - A
Section - I
Short Answer Questions (2M)

1. Explain the formation of "Coordinate covalent Bond"?

A. In certain cases one atom contributes two electrons and the other atom contributes no electrons in the formation of the bond. The two electrons are shared by both the atoms. Bonds of this type are called "Coordinate Covalent Bonds".

2. Draw the bond formation in HC*l* Molecule?

A.



Formation of HCl molecule by s-p overlap
1. 1s of Hydrogen atom 2. 2pz of chlorine atom 3. HCl molecule

3. Show the electron dot picture of H_2 Molecule?

A. $H^{\bullet} + H^{\times} \rightarrow H^{\bullet}_{\times}H$ (or) H – H

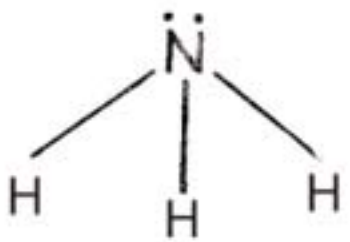
In the above a dot and a cross are given to represent the electrons from the two hydrogen atoms. But after the bond formation it is impossible to distinguish the two electrons. Both electrons are shared by two hydrogen atoms and thus each hydrogen atoms and thus each hydrogen atom attains the electronic configuration of the inert gas element; Helium. The bond is represented by the line '–' between the two atoms H – H.

4. Draw the shape of Ammonia (NH_3) molecule and Explain it?

(or)

What is the shape of Ammonia (NH_3) molecule? Draw it?

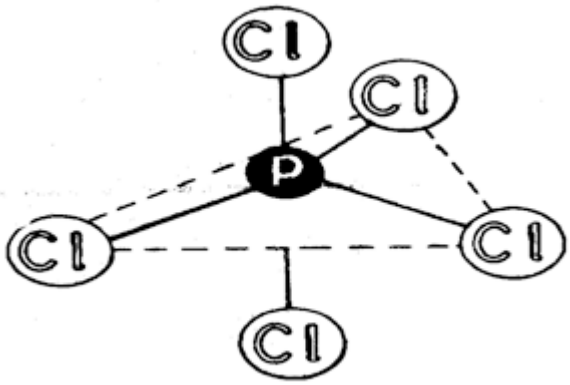
A. The shape of Ammonia molecule is pyramidal. In this, three hydrogens are in one plane and nitrogen above the plane. Nitrogen has one lone pair of electrons in Ammonia.



Shape of Ammonia Molecule

5. What is the shape of PCl_5 molecule?

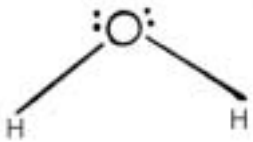
A. In vapour state PCl_5 molecule has a trigonal bipyramid structure. In PCl_5 three chlorines and phosphorous lie in one plane, one chlorine above the plane and one chlorine below the plane.



Shape of Phosphorous Penta Chloride (PCl_5)

6. Draw the shape of water molecule and explain it?

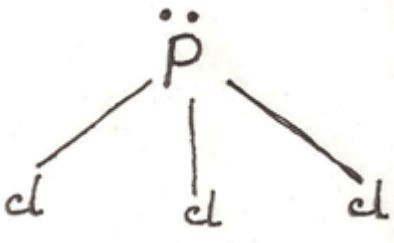
A. Water molecule is non-linear and has a 'V' shape as shown in the below figure.



Shape of Water Molecule

7. Draw the shape of phosphorus trichloride (PCl_3)?

A. PCl_3 has a pyramidal structure. Three chlorines are in one plane and phosphorus has above the plane. Phosphorus has one lone pair of electrons.



Shape of PCl_3 Molecule

8. Draw the shape of CO_2?

A. CO_2 is a linear molecule with carbon at the center and the oxygen atoms lying on either side. Carbon forms a double bond with oxygen. Thus its structure is

O = C = O

9. Explain the formation of coordination covalent bond in NH_4^+ ion?

A. In NH_3 (Ammonia) a lone pair of electrons are available on nitrogen [: NH_3]

In H^+ ion the 1s orbital is empty.

Ammonia (NH_3) which has a lone pair of electrons on nitrogen contributes the pair for bond formation with H^+.

This results in the formation of coordination covalent bond.

$H^+ + :NH_3 \rightarrow [H: NH_3]+$

(or)

$H^+ \leftarrow NH_3$

(or)

NH_4^+

10. Write the formation of $F_3B : NH_3$ molecule?

A. Ammonia (NH_3) molecule has pyramidal shape and has a lone pair of electrons on the nitrogen on the other had born trifluoride (BF_3) has planar triangular shape and has one empty 'p' orbital. NH_3 molecule donates the pair of electrons to BF_3 and forms a coordinate covalent bond. This is shown below.

$F_3B + :NH_3 \rightarrow F_3B: NH_3$

$F_3B \leftarrow NH_3$

After the bond formation, both the electrons are shared by BF_3 and NH_3 molecules.

11. Why sigma bond is stronger than ''pi'' bond?

A. The strength of the bond depends on extent of overlap. The extent of overlap is maximum in sigma bond and minimum in sigma bond and minimum in "pi" bond. Hence sigma bond is stronger than "pi" bond.

12. Why do atoms combine?

A. Atoms are less stable where as molecules are more stable. So in order to get stabiling atoms will combine.

13. Compare the "sigma" bond and ''pi'' bond?

A.

Sigma Bond (σ)	Pi Bond (π)
1. The bond formed by the end-end overlap of orbitals of atoms is called sigma bonds.	1. The bond formed by the side on overlap of orbitals of atoms is called "pi" bond.
2. It has independent existence.	2. It has no independent existence
3. It is the strongest bond.	3. It is the weakest bond

14. Compare the "sigma" bond and ''pi'' bond?

A.

Ionic Bond	Covalent Bond
1. This bond is formed by the transfer of electrons from one atomto another	1. This bond is formed by the share of electrons between two atoms.
2. **Eg:** NaCl, MgO, CaO	2. **Eg:** H_2, Cl_2, HCl

15. Distinguish between covalent bond and coordinate covalent bond?

A.

Ionic Bond	Covalent Bond
1. The bond formed by the share of electrons between two atoms is called covalent bonds.	1. This bond is formed by the share of electrons between two atoms.
2. **Eg:** H_2, Cl_2, HCl etc	2. **Eg:** $NH_3 - BF_3$, H_3O^+. etc

Section - II
Very Short Answer Questions (1M)

1. How Ionic bond is formed?

A. Complete transfer of one (or) more electrons form one atom to another will lead to the formation of ionic (or) electro covalent bond.

2. Explain how covalent bond is formed?

A. Sharing of the electrons will lead to the formation of covalent bond.

3. Can 'π' bond exists independently?

A. π bond cannot exist independently

4. Write the examples of molecules having sigma bonds?

A. H_2, HCl, Cl_2, BF_2, BeF_2 etc.

5. Give the examples having π bonds.

A. Ethylene (CH_4), Carbondioxide (CO_2), Oxygen (O_2), Nitrogen (N_2)

6. Give three examples of molecules having double bond?

A. Ethylene (CH_4), Carbondioxide (CO_2)

7. Give two examples of molecules having a triple bond?

A. Nitrogen (N_2), acetylene (C_2H_2), Calcium Carbide (CaC_2) and HCN

8. Name two molecules having pyramidal shape?

A. Ammonia (NH_3), Phosphorous trichloride (PCl_3)

9. What is the shape of PCl_5 molecule?

A. In the vapour state PCl_5 molecule has a trigonal bipyramid structure.

10. Write the shape of water molecules?

A. Water molecule is non-linear and has a "V" Shape.

11. Name two molecules having p – p over lap?

A. Br_2, Cl_2, O_2, I_2

12. Which orbital can form π bond?

A. 'p' and 'd' orbitals can form π bond.

13. What is the shape of carbondioxide molecule?

A. Linear

14. What are multiple covalent bonds?

A. Molecules having double and triple covalent bonds are called as multiple covalent bonds.

15. Give of molecules having linear structure?

A. CO_2, $BeCl_2$ and HCN.

16. Name two molecules having coordinate bond?

A. H_3O^+, $[Fe(H_2O)_6]^+$

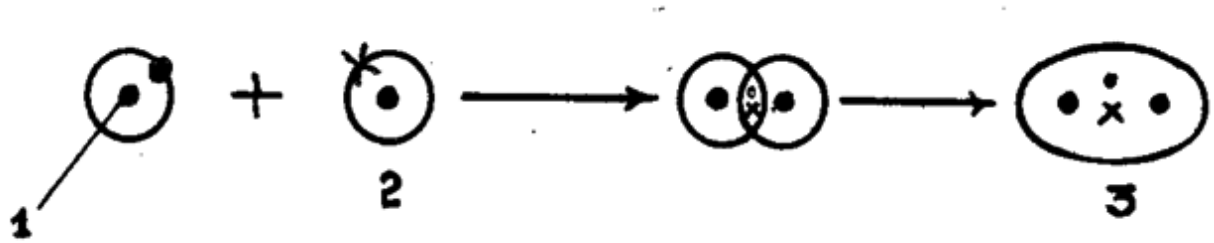
Section - III
Long Answer Questions (4M)

1. Discuss the types of overlaps that are possible with 's' and 'p' oribtals?

A. Three types of overlaps are possible with 's' and 'p' orbitals. They are

i) s-s overlap ii) p-p over lap iii) s-p overlap

i) s-s overlap : Consider two hydrogen atoms having one unpaired electron each approaching each other. Each hydrogen has an unpaired electron in the '1s' orbital. As these two hydrogen atoms approach each other 's' orbitals gets overlap at the appropriate inter nuclear distance. This is shown in the figure.



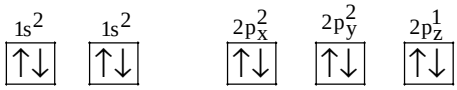
Formation of H_2 Molecules by s-s overlap

1. Nucleus, 2. 1s of hydrogen atom 3. H_2 molecule

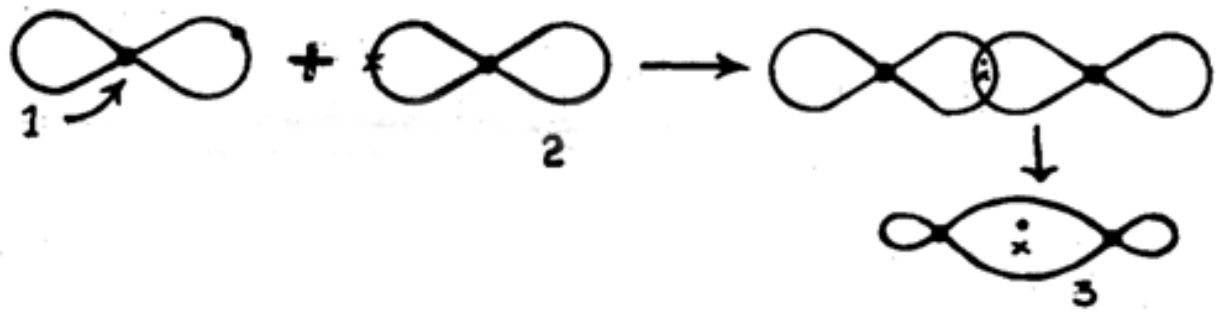
ii) p-p overlap : The overlap of 'p' orbitals of two atoms is called p-p overlap. p-p overlap observed in the diatomic molecules of F_2, Cl_2, Br_2, O_2 etc.

Consider the formation of the diatomic molecule of fluorine (F_2)

The electronic configuration of fluorine is $1s^2 2s^2 2p^5$. It is also represented as



Thus fluorine has one unpaired electron in $2p_z^1$ orbital. So when two fluorine atoms approach each other, their $2p_z$ orbitals will overlap at the appropriate inter nuclear distance as shown in the figure.



Formation of F_2 Molecules by p-p overlap

1. Nucleus, 2. $2p_z$ of fluorine atom 3. F_2 molecule

s-p overlap: The overlap of 's' orbital of one atom with 'p' orbital of another atom is called s-p overlap.

Ex: HC*l*, HBr, HI and H_2S

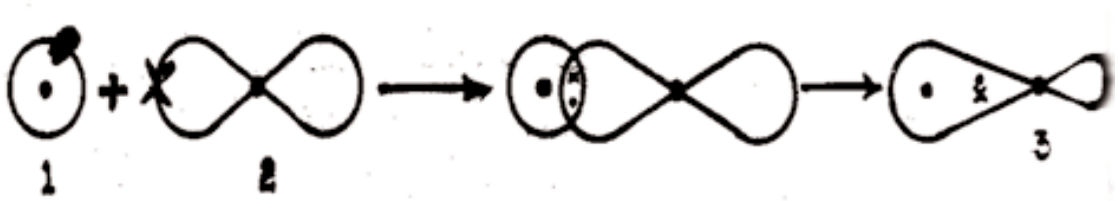
Consider HC*l* formation. The electronic configuration of hydrogen (1) and chlorine (17) are $1s^1$ and $1s^22s^22p^63s^23p$ respectively. They are represented as

Hydrogen = $1s^1$ ↑

Chlorine: $1s^22s^22p^63s^23p^5$

$1s^2$ ↑↓ $2s^2$ ↑↓ $2p_x^2$ ↑↓ $2p_y^2$ ↑↓ $2p_z^2$ ↑↓ $3s^2$ ↑↓ $3p_x^2$ ↑↓ $3p_y^2$ ↑↓ p_z^1 ↑

Hydrogen has one unpaired electron in it's orbital and chlorine has one unpaired electron in the $3p_z$ orbital. Therefore when they approach each other their 's' and 'p' orbitals overlap at appropriate inter nuclear distance as shown in the figure.



Formation of HCl molecule by s-p overlap

1. 1s of Hydrogen atom 2. 2pz of chlorine atom 3. HCl molecule

2. Explain the formation of a double bond?

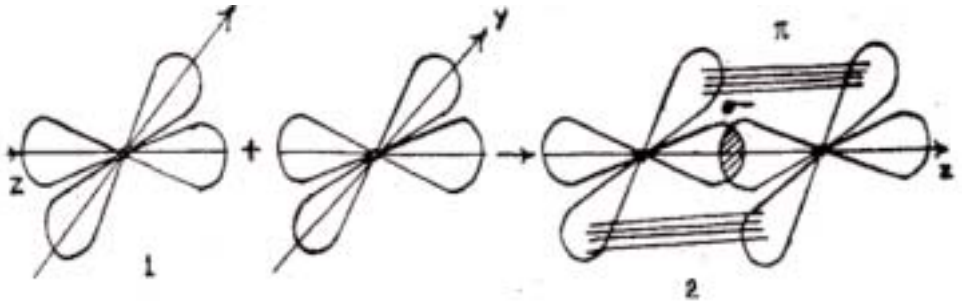
A. The bond formed by the share of two pairs of electrons between two atoms is called a double bond. The molecules having double bonds are O_2, CO_2 and C_2H_2

Explanation: Consider the formation of oxygen (O_2) molecule. The electronic configuration of oxygen is $1s^22s^22p^4$.

$1s^2$ ↑↓ $2s^2$ ↑↓ $2p_x^2$ ↑↓ $2p_y^1$ ↑ $2p_z^1$ ↑

Oxygen has two unpaired electrons one each in $2p_y$ and $2p_z$ orbitals. The $2p_z$ orbital of one oxygen atom overlaps with the $2p_z$ orbital of another oxygen by end - on - end overlap resulting in the formation of a 'σ' bond. This leaves 2py orbital containing one electron in each oxygen atom. These two $2p_y$ orbitals can't overlap end-on-end. $2p_z$ and $2p_y$ orbitals are perpendicular to each other.Two $2p_z$ orbitals have already overlapped end-on-end. The remaining two 2py orbitals are parallel to each other. They overlap side ways to form a 'π' bond. Thus in oxygen molecule two $2p_z$ orbitals overlap end-on-end to give a sigma (σ) bond and two 2py orbitals

overlap sideways to form a "π" bond. Thus oxygen molecule has two bonds, one "σ" bond and one π bond; often referred to as a double bond.



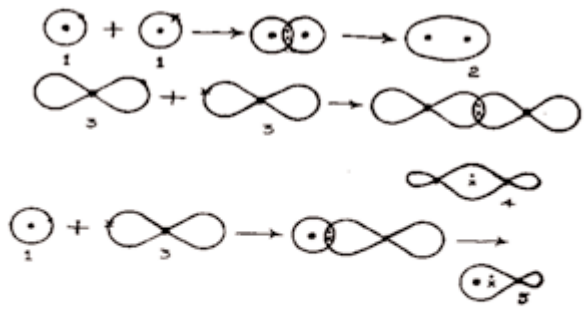
Formation of a double bond in O_2 Molecule

1. p_y and p_z orbitals of oxygen atom 2. Oxygen molecule

3. Explain how "sigma" and "pi" bonds are formed?

A. **Sigma bond (End-on-End overlap) :** In the end-on-end type of overlap, the end part of an orbital overlaps with the end part of another orbital. The resultant bond formed by such an overlap is called sigma bond (σ - bond). In this type of bond maximum orbital overlap takes place and therefore the bond formed is strong. "σ" bond can exist independently.

Examples: Molecules having "σ " bonds are H_2, HC*l*, Cl_2, Br_2, BeF_2... etc.

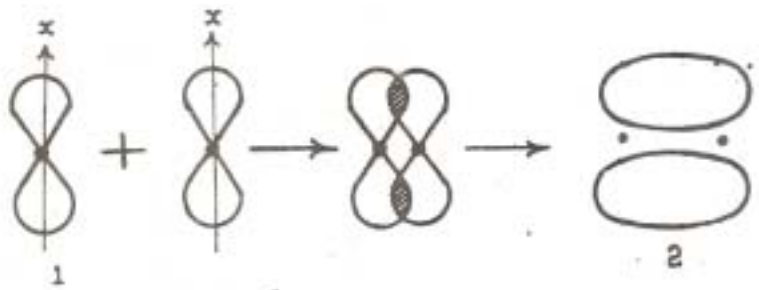


Formation of s-s, p-p and s-p bonds by end-on-end overlap

1. S-orbital 2. S-s bond 3. P_z orbital
2. 4. P-P bond 5. S-p bond

b) Pi bond: An orbital overlaps with another side ways. The bond formed by such an overlap is called "pi" bond (π - bond). The d-orbitals are capable of formation of "pi" (π) bond. This is a weak bond and cannot exist independently.

Examples: Molecules "π" having bond are C_2H_4 (ethylene), CO_2, O_2, N_2 ...etc.



Formation of a bond by partial overlap of two P_x orbital

1. P_x orbital 2. Bond

4. Explain the formation of a coordinate covalent bond?

A. The bond in which one of the two combining atoms contribute the electrons and those are shared by the both atoms is called coordinate covalent bond.

Ex: NH_3: BF_3, NH_4^+, H_3O^+...

Formation: Ammonia (NH_3) molecule has pyramidal shape and has a lone pair of electrons on nitrogen. On the other hand boron trifluoride (BF_3) has planar triangular shape and has one empty 'p' orbital. NH_3 molecule donate the pair of electrons to BF_3 and forms a coordinate covalent bond. This is shown in the below.

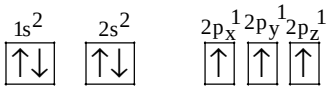
$F_3B + : NH_3 \rightarrow F_3B: NH_3$ (or) $F_3B \leftarrow NH_3$

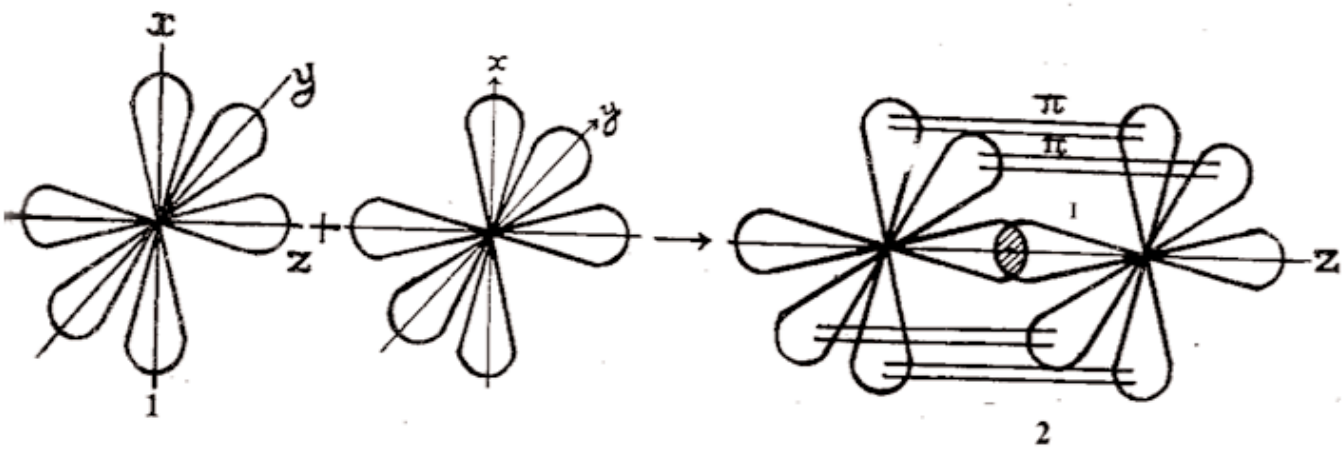
5. Explain the formation of a triple bond?

A. Triple bond: The bond formed by the share of three pair of electrons between two atoms is called triple covalent bond or triple bond.

Eg: N_2, C_2H_2, HCN.

Formation of triple bond in Nitrogen molecule: The electronic configuration of nitrogen is $1s^2 2s^2 2p^3$.





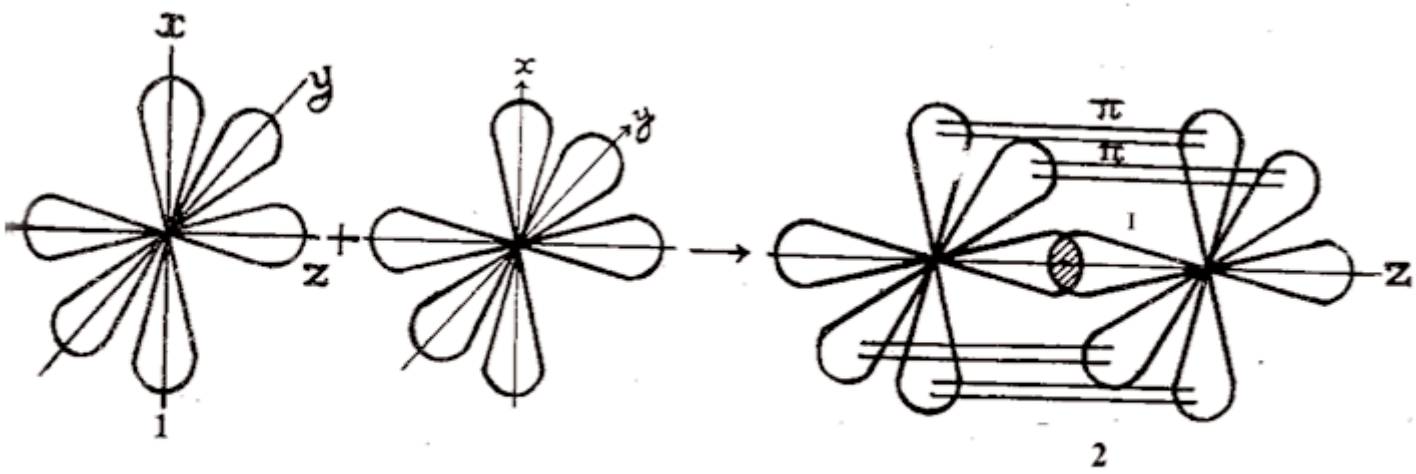
Formation of a triple bond in N_2 molecule

1. P_x, P_y, and P_z orbitals of nitrogen atom 2. N_2 molecule

There are three unpaired electrons, one each in $2p_x$, $2p_y$, $2p_z$ orbitals. The two 2pz orbitals overlap end-on-end to give rise to a sigma (σ) bond. The remaining two orbitals [$2p_x$ and $2p_y$] are perpendicular to $2p_z$ and perpendicular to each other. Therefore they cannot overlap end-on-end. Two $2p_x$ and two $2p_y$ orbitals overlap side ways to give rise to two "p" bonds. Thus n nitrogen a triple bond (one sigma and two p bonds) is formed the formation of triple bond in nitrogen molecule is shown in figure.

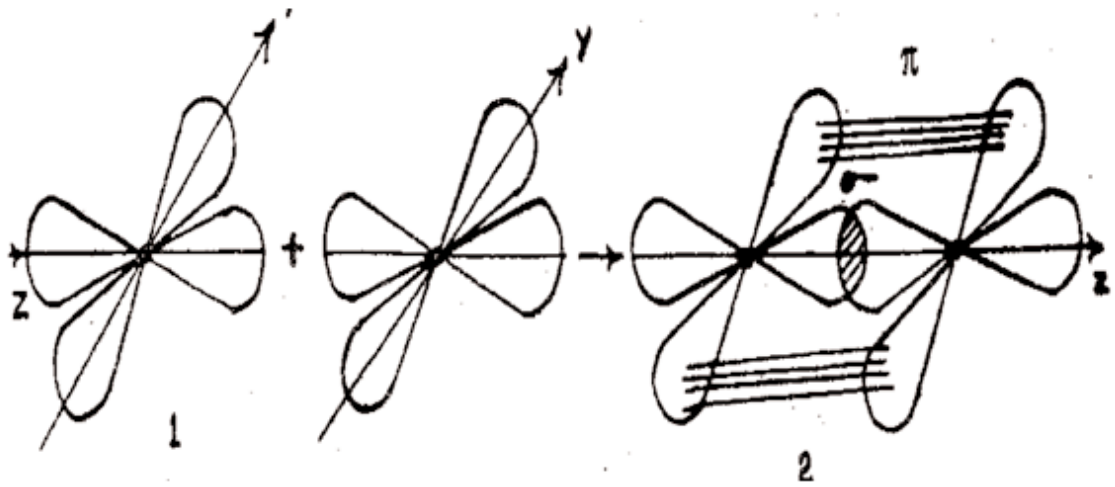
Section - IV
Diagrams (5M)

1. Draw the diagram showing the formation of a triple bond in nitrogen molecule?



Formation of a triple bond in N_2 molecule
1. P_x,P_y, and P_z orbitals of nitrogen atom 2. N_2 molecule

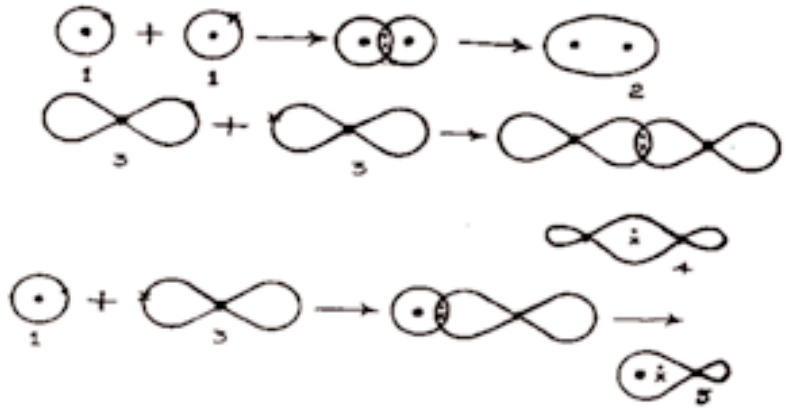
2. Draw the diagram showing the formation of a double bond in oxygen molecule?



Formation of a double bond in O_2 molecule
1. P_y and Pz orbitals of oxygen atom 2. Oxygen molecule

3. Draw the diagram showing (1) σ bond (2) π bond

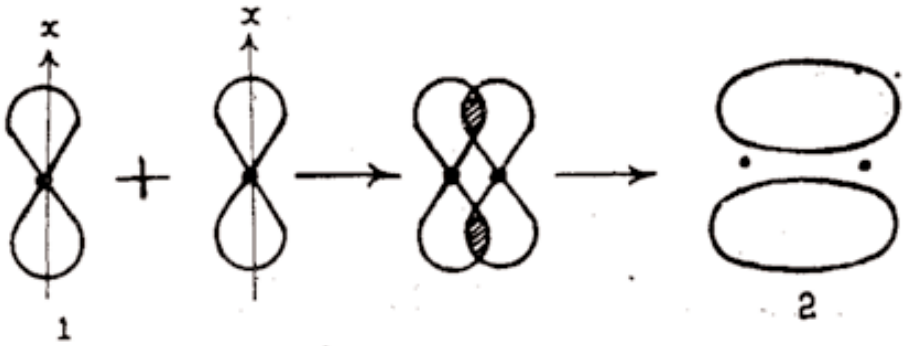
1) σ bond



Formation of s-s, p-p and s-p bonds by end-on-end overlap

1. S-orbital 2. S-s bond 3. P_z orbital
2. 4. P-P bond 5. S-p bond

2) π bond



Formation of a bond by partial overlap of two P_x orbital

1. P_x orbital 2. Bond

PART - B
Multiple Choice

1. Complete transfer of electrons from one atom to another leads to the formation of

a) Ionic bond
b) Covalent bond
c) Coordinate Covalent Bond
d) None

2. Coordinate covalent bond is present in

a) HCl
b) H_2O
c) H_3O^+
d) H_2

3. Shape of CO_2 is

a) "V" Shape
b) Pyramidal
c) Linear
d) Tetrahedral

4. s-p overlap is present in

a) H_2
b) Cl_2
c) O_2
d) HCl

5. Which is more stable

a) Combined state of atoms
b) Individual atoms
c) Complex state of atoms
d) None

6. p-p overlap observed in the

a) Br_2
b) Cl_2
c) O_2
d) All the above

7. s-p overlap observed in the

a) H_2s
b) HBr
c) HI
d) All the above

8. How many unpaired electrons are there in ''nitrogen''

a) 1
b) 2
c) 3
d) 4

9. How many unpaired electrons are there in oxygen

a) 1
b) 2
c) 3
d) 4

10. Which molecule has pyramidal shape?

a) NH_3
b) C_2H_2
c) CaC_2
d) HCN

11. Which bond formations explain by the Lewis acid base concept?

a) Ionic Bond
b) Covalent Bond
c) Hydrogen Bond
d) Coordinate Bond

12. The following molecule has linear structure

a) PCl_5
b) CO_2
c) BF_3
d) PCl_3

13. The shape of Boron trifluoride (BF_3) molecule is

a) Pyramidal
b) Tetrahedral
c) Trigonal bi-pyramidal
d) Trigonal Planar

14. In the Ammonia boron trifluoride the donor is

a) N
b) B
c) N and B
d) None

15. In a double bond

a) Two pi (π) bonds
b) Two sigma (σ) bonds
c) one sigma (σ) and one pi (π) bond
d) None

16. Which of the following has only sigma bond?

a) N_2
b) O_2
c) Br_2
d) None

17. Which of the following has triple bond?

a) I_2 b) F_2 c) N_2 d) Br_2

18. Which of the following is non-linear?

a) H_2O b) CO_2

c) C_2H_2 b) Cl_2

19. Bond angle in water molecule is

a) 90° b) 104°

c) 120° d) 180

20. End-on-end overlap results in

a) pi (π) bond b) sigma (σ) bond

c) Hydrogen Bond d) Ionic bond

KEY

1) a	2) c	3) c	4) d	5) a	6) d	7) d
8) c	9) b	10) a	11) d	12) d	13) d	14) a
15) c	16) c	17) c	18) a	19) b	20) b	

Fill in the Blanks

1. Sharing of electrons between two atoms leads to the formation of _____ bond.
2. _____ type overlap is present in F_2
3. NH_3 has _____ shape.
4. N_2 has _____ sigma and _____ π bonds.
5. Oxygen has _____ lone pairs of electrons in water molecule.
6. Formation of chemical bond involves _____ of electrons.
7. Bond strengths arise due to the _____of the valence orbitals that overlap.
8. In water, after the bond formation the oxygen atom is left with _____ lone pair of electrons.
9. Phosphorous has _____ lone pair of electrons in PCl_3
10. Boron trifluoride (BF_3) has _____ shape.
11. A molecule is _____ stable than the atoms present in it.
12. _____ bond is found in the Ammonium (NH_4^+) ion.
13. _____ type of overlap is present in H_2
14. Molecules having single bonds have only _____ bonds.
15. In the coordinate covalent bond, both the electrons are supplied by _____
16. In a double bond _____ sigma (σ) and _____ pi (π) bond are present.
17. Sigma (σ) bond is _____ than pi (π) bond.
18. HCN has _____ structure.
19. In C_2H_2 (Acetylene) bonds there in between carbon and carbon.
20. s-s overlap is present in _____
21. p-p overlap is present in _____
22. s-p overlap is present in _____

KEY:

1) Covalent	2) end-on-end	3) Pyramidal
4) One (1) two (2)	5) two	6) Redistribution
7) Nature	8) two	9) one
10) Planar triangular	11) more	12) Coordinate Covalent

13) end-on-end
14) Sigma (σ)
15) One of the atoms
16) one, one
17) more stable
18) Linear
19) three
20) Hydrogen (H_2)
21) Fluorine (F_2)
22) HC*l*

Match the following

SET-1

Group A		Group B
1. V- shape	( )	a) Boron trifluoride
2. Pyramidal	( )	b) Phosphorous Penta Chloride
3. Trigonal bipyramidal	( )	c) Carbondioxide
4. Planar Triangular	( )	d) Ammonia
5. Linear	( )	e) Water

SET-2

Group A		Group B
1. s-s overlap	( )	a) Hydrogen Sulphide
2. p-p overlap	( )	b) σ-bond
3. s-p overlap	( )	c) Chlorine molecule
4. end-on-end overlap	( )	d) Hydrogen Molecule
5. side-on overlap	( )	e) π-bond

SET-3

Group A		Group B
1. Zero Group elements	( )	a) Covalent Bond
2. Diamond	( )	b) Coordinate Covalent Bond
3. Lewis acid base concept	( )	c) Chemical bond
4. Triple bond	( )	d) Stable electronic Configuration
5. Redistribution of electrons	( )	e) Multi covalent bond

KEY

SET-1
1. e, 2. d, 3. b, 4. a, 5. c

SET-2
1. d, 2. c, 3. a, 4. b, 5. e

SET-3
1. d, 2. a, 3. b, 4. e, 5. c