Review 5
part 2

B- Lewis structures, resonance, formal charges

- **Write the Lewis dot symbols of the following compounds**

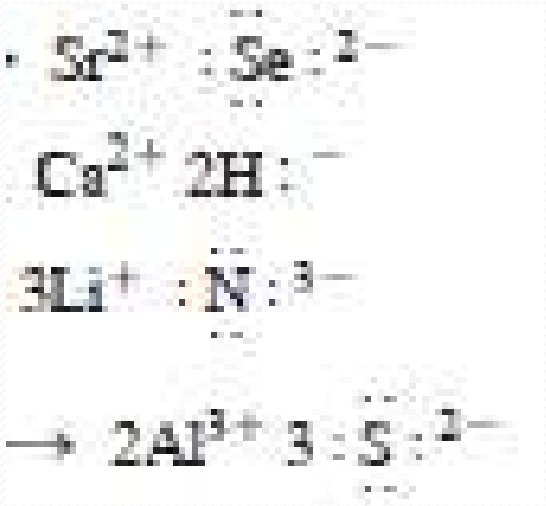
SrSe

CaH_2

Li_3N

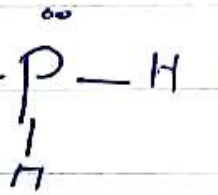
Al_2S_3

Answer:

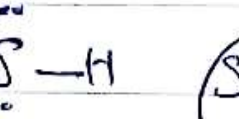
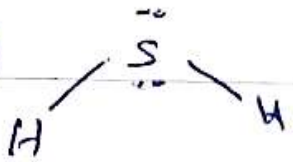


① ICL :- 7 + 7 = 14 electron = 7 pair of electrons

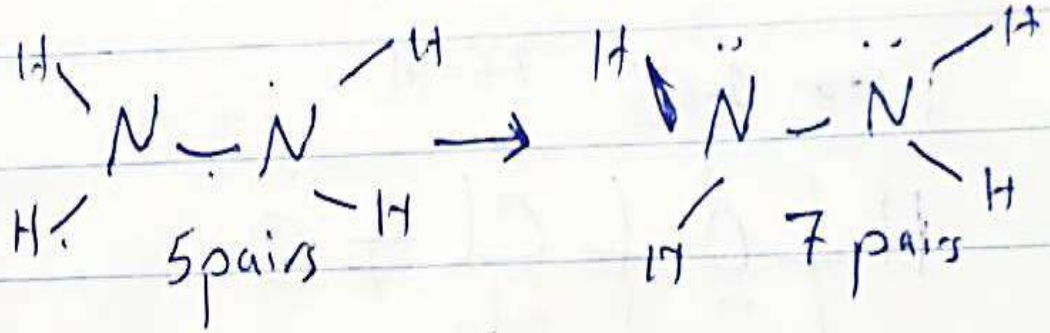
② PH_3 :- 5 + (3×1) = 8 electrons = 4 pair of electrons

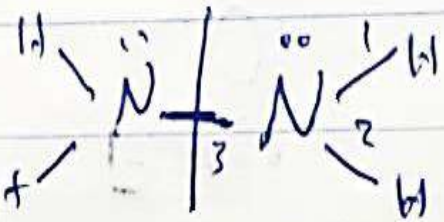
Lewis structure  Shape AB_3X → Trigonal Pyramidal

③ H_2S :- (2×1) + 6 = 8 electrons = 4 pairs.

Lewis structure  Shape  bent or AB_2X_2 angular

④ N_2H_4 : $(2\times5)+(4\times1) = 14\ e^- = 7$ pair



geometry 

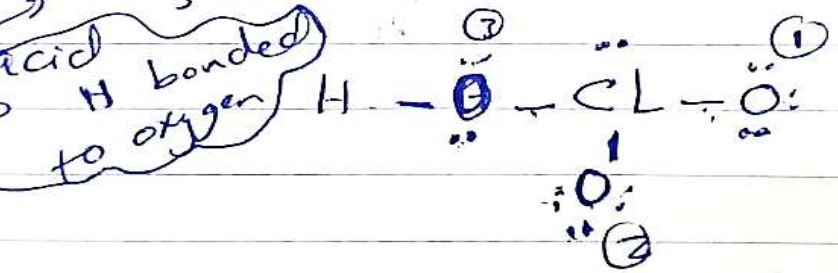
for each N: 3 bonding pairs

1 lone pair

AB_3X → trigonal pyramidal

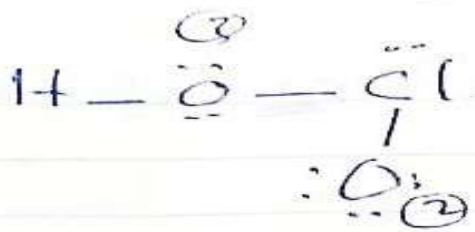
⑤ $HClO_3$ ∴ $1 + 7 + (3 \times 6) = 26\ e^- = 13$ pairs

acid so H bonded to oxygen

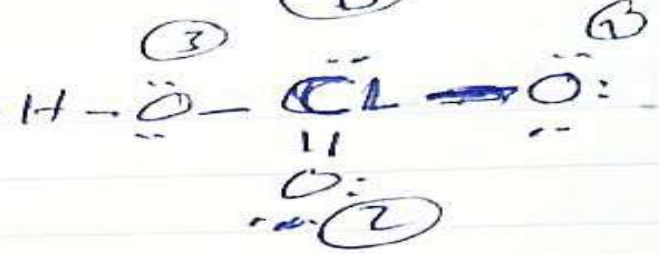


→ Cl in period 3 so can obey expanded octet

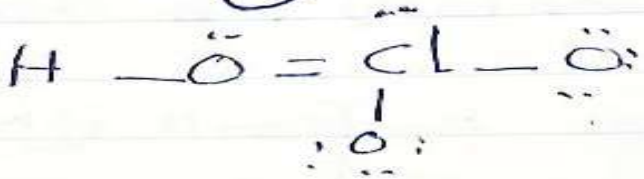
(A)



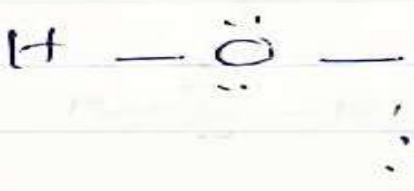
(B)



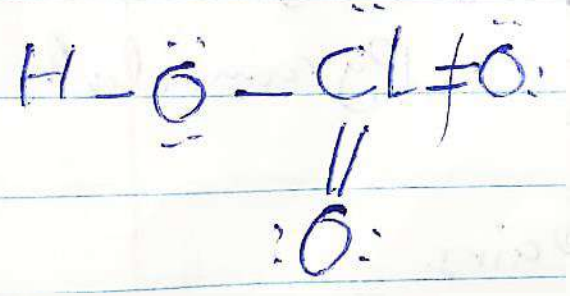
(C)



(D) the original one.



(E)

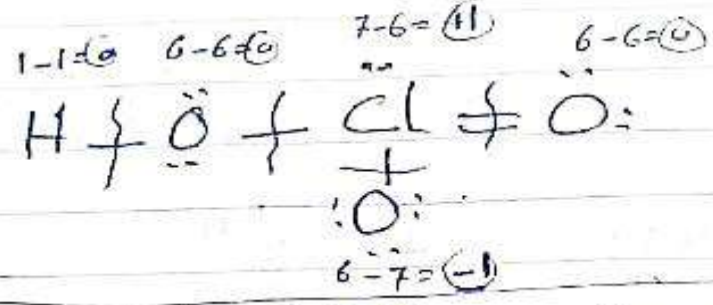


which is more plausible ??

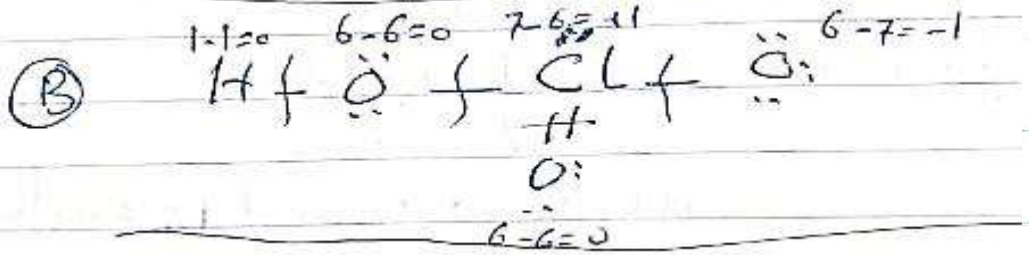
which is most plausible...

→ show formal charges

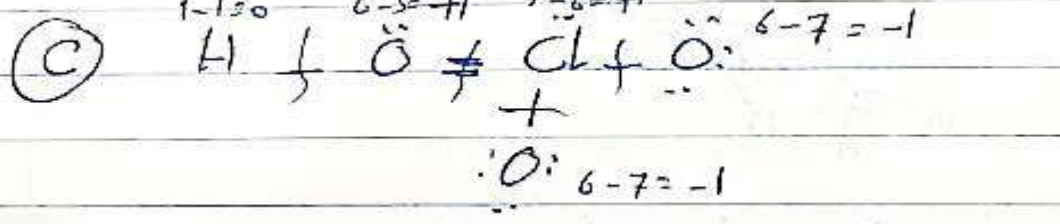
(A)



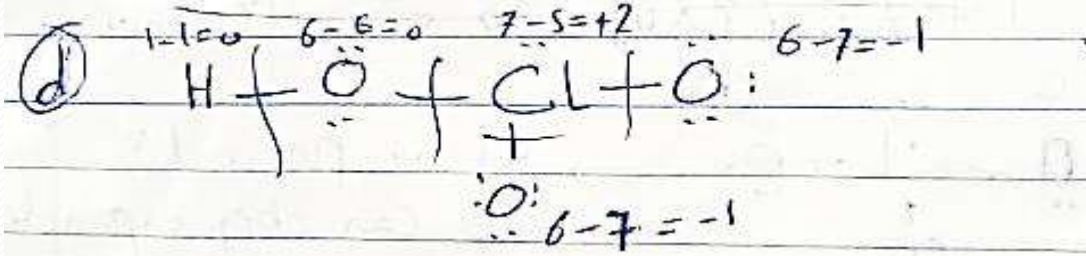
(B)



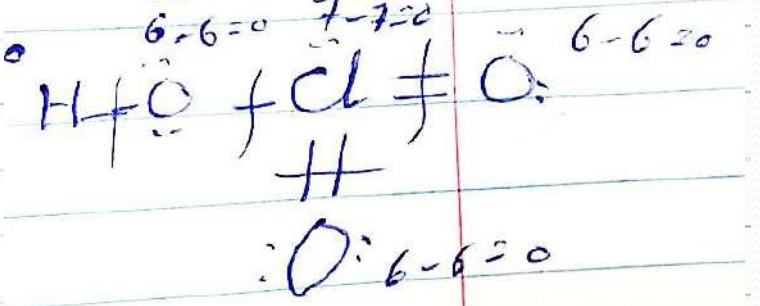
(C)



(d)



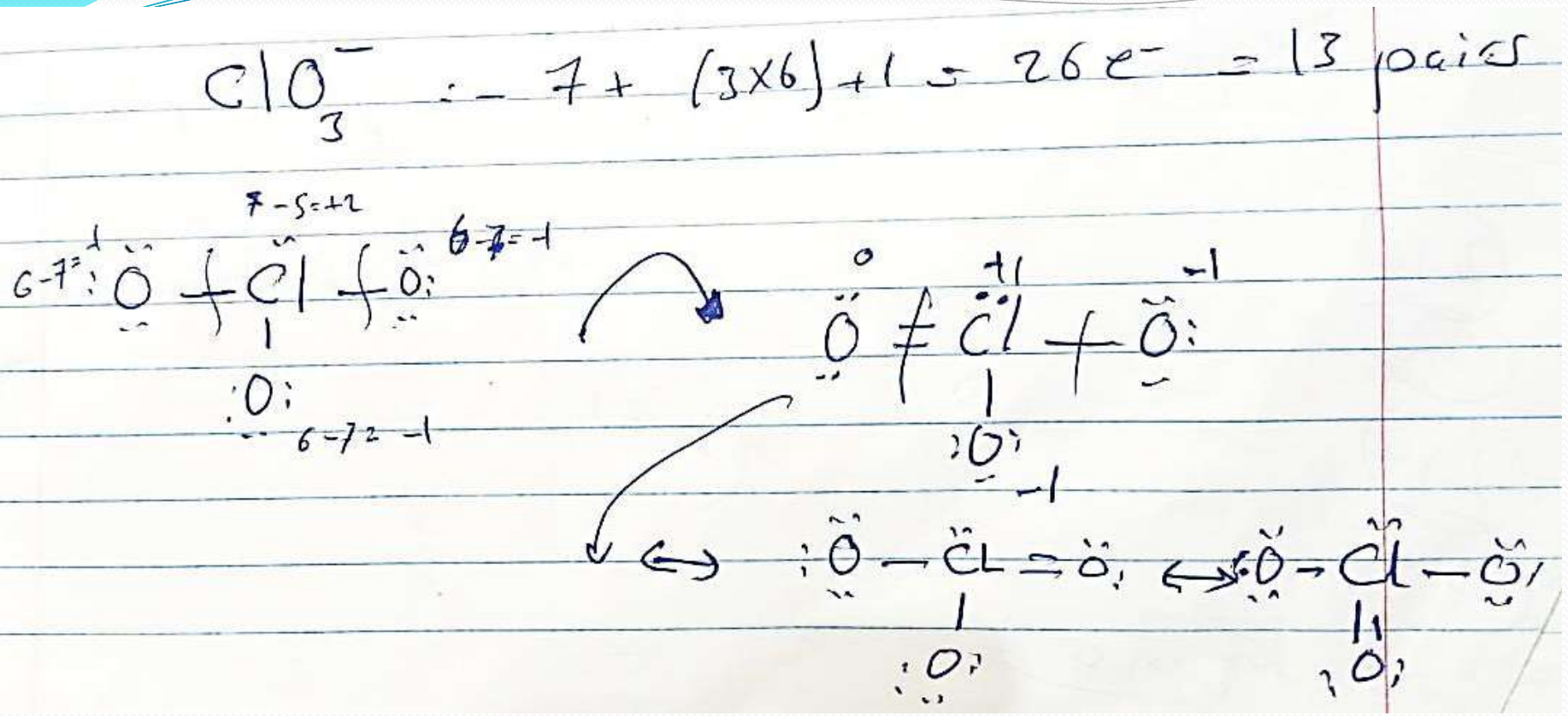
(E)



a lot of formal charges

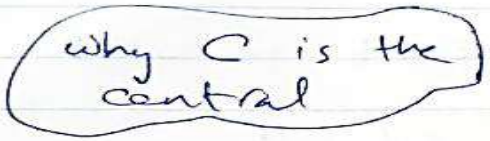
big formal charge

ClO_3^- :- 7 + (3x6) + 1 = 26 e^- = 13 pairs

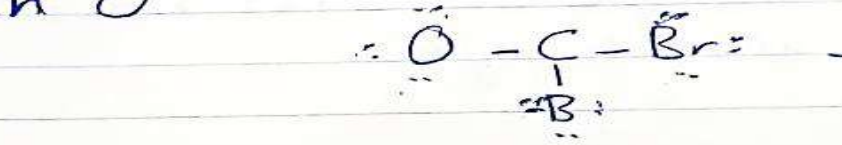


⑥ $COBr_2 \rightarrow 4 + 6 + (2 \times 7) = 24\ e^- = 12$ pairs

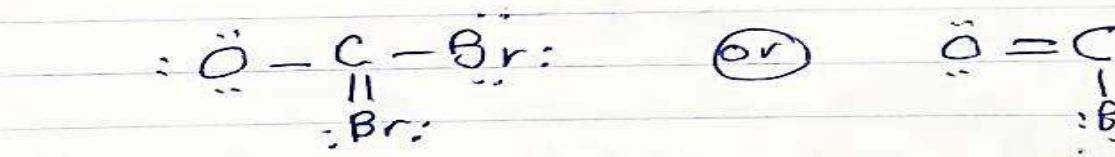
why C is the central



the less electronegative / Br halogen → so terminal than O



→ C → no octet rule so double bond

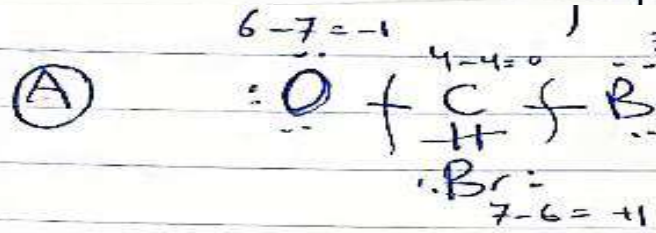


(A) (B)

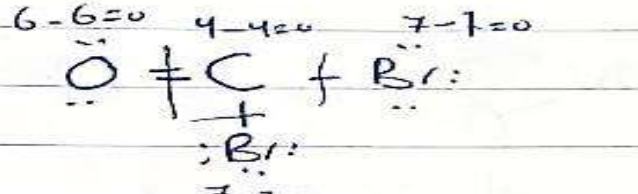
which is more plausible A or B??

formal charges

(A)



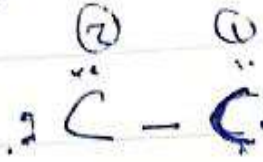
(2)



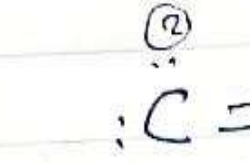
no formal charges

so (B) is more plausible

(7) C_2^{-2} :- $(2\times4)+2 = 10\ e^- = 5$ pairs



→ no octet for both



→ no octete for ①

→ octet rule

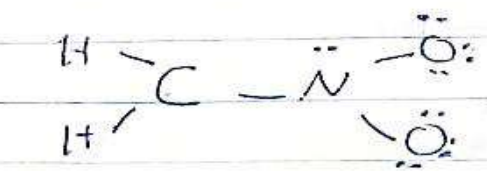
formal charges

4-5= 4-5=-1

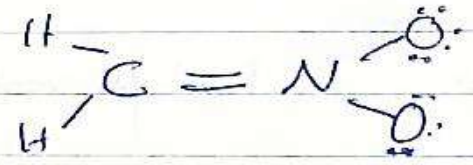
-1

Sum of formal Charges = -2 = Charge of ions

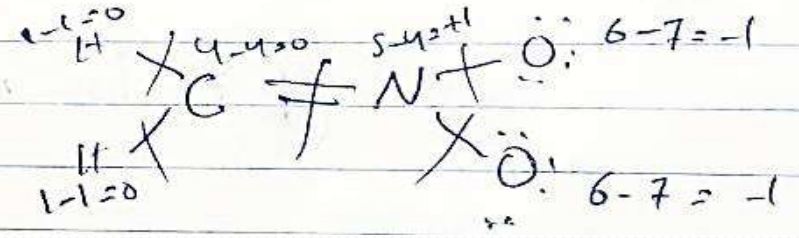
(8) $CH_2NO_2^-$ → $4+(2\times1)+5+(2\times6)+1 = 24\ e^- = 12$ pairs



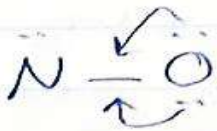
→ C → no octet



→ Show formal Charges



(9) NO^+ → $5+6-1 = 10\ e^- = 5$ pairs



→ N → no octet

$N \equiv O$ → formal Charges

$N \not\equiv O$

5-5=0 6-5=+1

(10) HN_3 → H — N — N — N

$1 + (3 \times 5) = 16\ e^- = 8$ pairs

H — N = N — N: → No octet for one of the N

resonance hybrids

(1) H — N ≡ N — N: 1−1=0, 5−4=+1, 5−4=+1, 5−7=−2

(2) H — N = N = N: 1−1=0, 5−5=0, 5−4=+1, 5−6=−1 ✓✓

(3) H — N — N ≡ N 1−1=0, 5−5=0, 5−6=−1, 5−4=+1 ✓✓✓

(11) CNO^- → $4 + 5 + 6 + 1 = 16\ e^- = 8$ pairs

:C — N — Ö: → N → no octet

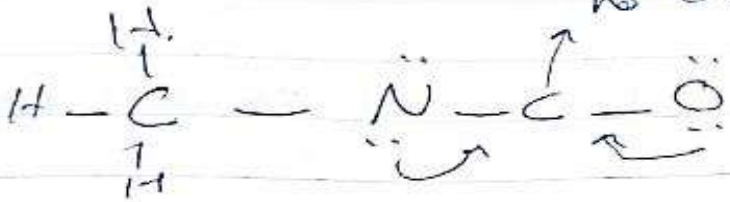
:C = N = Ö: 4−6=−2, 5−4=+1, 6−6=0 ✓ (2)

:C — N ≡ Ö: 4−7=−3, 5−4=+1, 6−5=+1 ×××

C ≡ N — Ö: 4−5=−1, 5−4=+1, 6−7=−1 ✓✓ (1)

(10) CH_3NCO → 4+3+5+4+6 = 22 e^- = 11 pairs

no octet



$CH_3 - \ddot{N} \neq C \neq \ddot{O}:$ → formal charges

$CH_3 \quad \ddot{N} \neq C \neq \ddot{O}:$

① 5-5=0 4-4=0 6-6=0 ✓✓

② $CH_3 \quad N \equiv C \quad \ddot{O}:$

5-4=+1 4-4=0 6-7=-1 ✓ X

③ $CH_3 \quad \ddot{N} = C \equiv \ddot{O}$

5-6=-1 4-4=0 6-5=+1 X X X

Hybridization

- ***It is important to understand the relationship between hybridization and the VSEPR model. We use hybridization to describe the bonding scheme only when the arrangement of electron pairs (both bonding and lone pairs) has been predicted using VSEPR.***

Procedure for Hybridizing Atomic Orbitals

- **The steps are as follows:**

1. Draw the Lewis structure of the molecule.

2. Predict the overall arrangement of the electron pairs (both bonding pairs and lone pairs) using the VSEPR model.

3. Deduce the hybridization of the central atom by matching the arrangement of the electron pairs with those of the hybrid orbitals shown in the following table.(remember that the number of electron pairs equals pure atomic orbitals that participate in the hybridization process).

TABLE 10.1 Arrangement of Electron Pairs About a Central Atom (A) in a Molecule and Geometry of Some Simple Molecules and Ions in Which the Central Atom Has No Lone Pairs

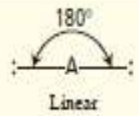
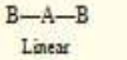
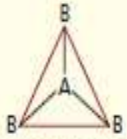
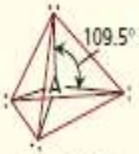
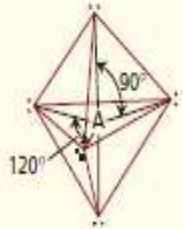
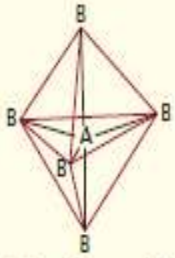
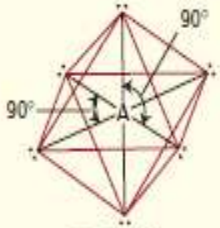
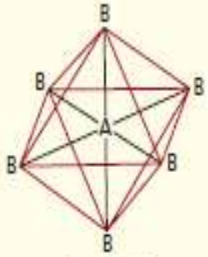
Number of Electron Pairs	Arrangement of Electron Pairs*	Molecular Geometry*	Examples
2	 Linear	 Linear	$BeCl_2$, $HgCl_2$
3	 Trigonal planar	 Trigonal planar	BF_3
4	 Tetrahedral	 Tetrahedral	CH_4, NH_4^+
5	 Trigonal bipyramidal	 Trigonal bipyramidal	PCl_5
6	 Octahedral	 Octahedral	SF_6

TABLE 10.4 Important Hybrid Orbitals and Their Shapes

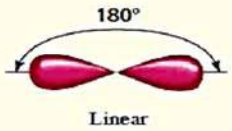
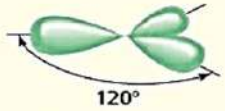
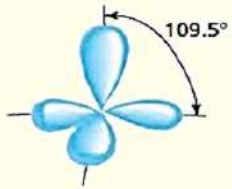
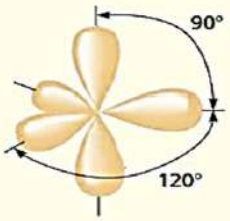
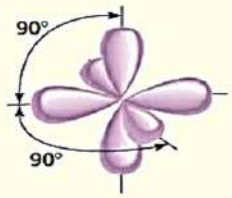
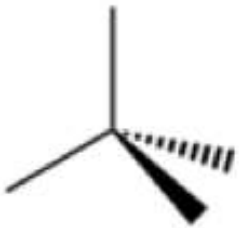
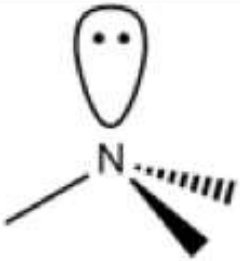
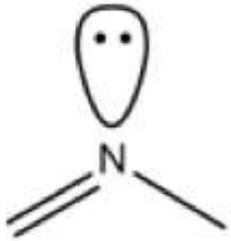
Pure Atomic Orbitals of the Central Atom	Hybridization of the Central Atom	Number of Hybrid Orbitals	Shape of Hybrid Orbitals	Examples
s, p	*sp*	2	 Linear	$BeCl_2$
s, p, p	sp^2	3	 Trigonal planar	BF_3
s, p, p, p	sp^3	4	 Tetrahedral	CH_4, NH_4^+
s, p, p, p, d	sp^3d	5	 Trigonal bipyramidal	PCl_5
s, p, p, p, d, d	sp^3d^2	6	 Octahedral	SF_6

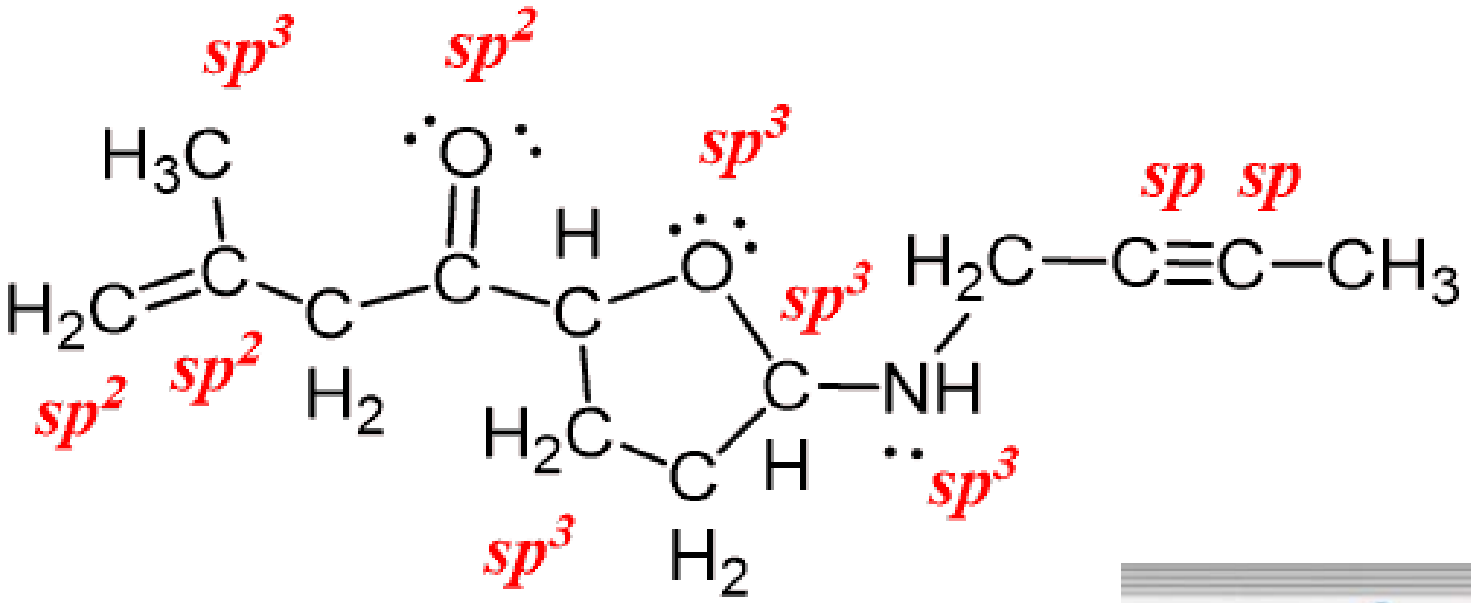
TABLE 10.2 Geometry of Simple Molecules and Ions in Which the Central Atom Has One or More Lone Pairs

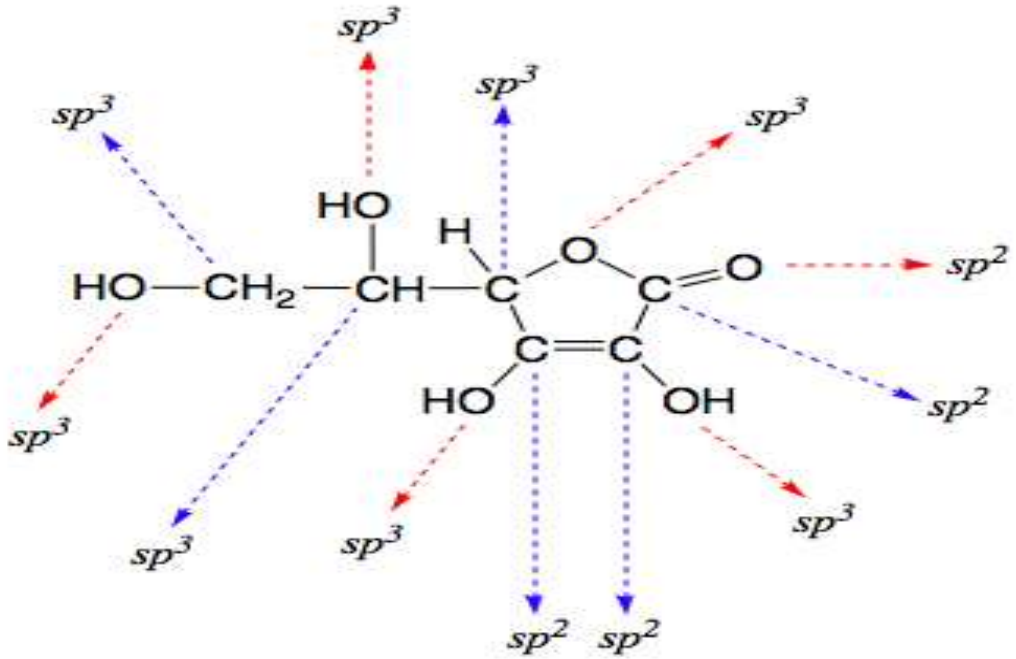
Class of molecule	Total number of electron pairs	Number of bonding pairs	Number of lone pairs	Arrangement of electron pairs*	Geometry	Examples
AB_2E	3	2	1	Trigonal planar	Bent	SO_2
AB_3E	4	3	1	Tetrahedral	Trigonal pyramidal	NH_3
AB_2E_2	4	2	2	Tetrahedral	Bent	H_2O
AB_4E	5	4	1	Trigonal bipyramidal	Distorted tetrahedron (or seesaw)	SF_4
AB_3E_2	5	3	2	Trigonal bipyramidal	T-shaped	ClF_3
AB_2E_3	5	2	3	Trigonal bipyramidal	Linear	I_3^-
AB_5E	6	5	1	Octahedral	Square pyramidal	BrF_5
AB_4E_2	6	4	2	Octahedral	Square planar	XeF_4

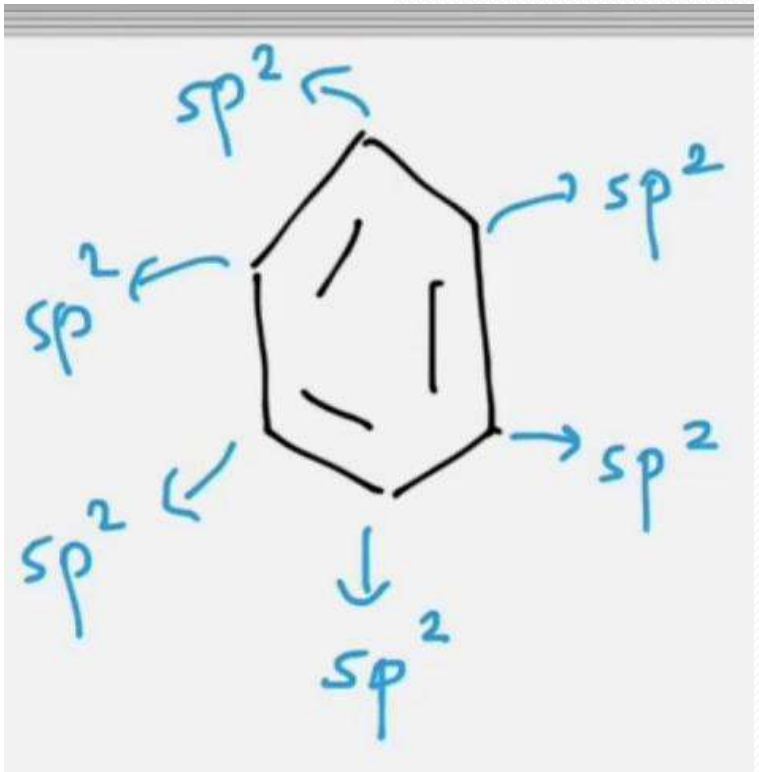
*The colored lines are used to show the overall shapes, not bonds.

No. of hybrid orbitals	Type of hybridization
3	sp^2
4	sp^3
4	sp^3
5	sp^3d
5	sp^3d
5	sp^3d
6	sp^3d^2
6	sp^3d^2

Bond Sites	4	4	4
Hybridization:	sp^3	sp^3	sp^3
Shape:			
Lone pairs:	0	1	2
Geometry:	Tetrahedral	Pyramidal	Bent
Bond Sites	3	3	2
Hybridization:	sp^2	sp^2	sp
Shape:			
Lone pairs:	0	1	0
Geometry:	Trigonal Planar	Bent	Linear


sp3
sp2
sp3
sp sp
H3C
O
H
O
H2C—C≡C—CH3
H2C
C
C
C
C
sp3
sp2
sp2
H2
C—NH
H2C
C
H
sp3
sp3
H2


sp3
sp3
sp3
sp3
HO
H
O
O
sp2
HO—CH2—CH—C
C
sp3
C=C
sp2
HO
OH
sp3
sp3
sp3
sp2
sp2


sp2
sp2
sp2
sp2
sp2
sp2
sp2

مع خالص تمنياتي لكم بالتوفيق
و النجاح