INDIAN SCHOOL AL WADI AL KABIR		
Class: XI	**DEPARTMENT OF SCIENCE:2026-27** **SUBJECT: CHEMISTRY**	**DATE: 24/08/2026**
WORKSHEET NO: 5 WITH ANSWERS	**TOPIC: CHEMICAL BONDING AND MOLECULAR STRUCTURE**	**A4 FILE FORMAT (PORTFOLIO)**
CLASS & SEC:	**NAME OF THE STUDENT:**	**ROLL NO.**

Multiple Choice Questions:

1. Both BF_3 and NF_3 are covalent molecules containing three fluorine atoms. However, BF_3 has a net dipole moment of zero, while is polar. This difference is primarily due to:

A) The higher electronegativity of Nitrogen compared to Boron.

B) The presence of a lone pair on nitrogen, which prevents the bond dipole from cancelling.

C) The larger atomic radius of Boron compared to Nitrogen.

D) The formation of coordinate covalent bonds in BF_3

2. Which of the following molecules contains a central atom that does NOT utilize d-orbitals in its hybridization scheme?

A) PCl_5
B) SF_6
C) CH_4
D) ClF_3

3. Consider the molecules $BeCl_2$, BCl_3 and CCl_4. The hybridization of the central atoms in these molecules follows the sequence:

A) sp, sp^2 ,sp^3
B) sp^2,sp, .sp^3
C) sp^3, sp^2, sp
D) sp, sp^3, sp2

4. Why is the bond angle in H_2O (104.5°) smaller than the bond angle in NH_3 (107°)?

A) Nitrogen is more electronegative than Oxygen.

B) The hybrid orbitals in Oxygen have more s-character.

C) Lone pair-lone pair repulsions in H_2O are greater than lone pair-bond pair repulsions in NH_3.

D) Oxygen has a larger atomic size than Nitrogen, leading to increased steric hindrance.

5. In which of the following substances will the hydrogen bond be strongest?

A) HCl
B) H_2O
C) HI
D) H_2S

6. sp^3d^2 hybridization is present in SF_6; find its geometry:
   A) octahedral geometry
   B) square planar geometry
   C) trigonal planar geometry
   D) tetrahedral geometry

7. Hybridisation in NH_3 is:
   A) sp
   B) sp^3
   C) sp^2
   D) sp^3d

8. Which ion is isoelectronic with CO?
   A) CN^-
   B) O_2^-
   C) N_2^+
   D) O_2^+

9. The formal charge of Carbon (C) in Methane (CH_4) is _____

   A) 4
   B) 1
   C) -4
   D) 0

10. Which of the following is the correct decreasing order of boiling points?

   A) $HF > H_2O > NH_3$
   B) $H_2O > HF > NH_3$
   C) $NH_3 > HF > H_2O$
   D) $NH_3 > H_2O > HF$

Assertion – Reason Questions

Choose the correct option for the questions given below

A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
B) Both Assertion (A) and Reason (R) are true but Reason (R) is NOT the correct explanation of Assertion (A).
C) Assertion (A) is true but Reason (R) is false.
D) Assertion (A) is false but Reason (R) is true.

11. **Assertion (A):** The molecule H_2 is more stable than the H_2^+ ion.
Reason (R): The bond order of H_2 is 1, whereas the bond order of H_2^+ is 0.5.

12. **Assertion (A):** In PCl_5, the three equatorial P-Cl bonds are quite stronger and shorter than P-Cl axial bonds.
Reason (R): The axial bond pairs suffer more repulsion from the equatorial bond pairs compared to the repulsion experienced by equatorial bond pairs.

13. **Assertion (A):** Though the central atom of both NH_3 and H_2O molecules are *sp*3 hybridised, the *H– N–H* bond angle is greater than that of *H–O–H*.

Reason (R): This is because the nitrogen atom has one lone pair while the oxygen atom has two lone pairs.

14. Assertion (A): PCl_5 has a trigonal bipyramidal shape.
Reason (R): There are 4 bond pairs and 1 lone pair around phosphorus in PCl_5.

15. **Assertion (A):** *NaBr* is more covalent than *NaF*.
Reason (R): Br^- being larger in size has lesser polarisability

SHORT ANSWER TYPE QUESTIONS(2 Marks)

16. Calculate the formal charge on each of the three oxygen atoms in the Ozone (O_3) molecule. Draw the structure and label the atoms 1, 2, and 3 for your calculation.

17. The electronegativity of Fluorine is higher than that of Nitrogen, yet the dipole moment of (NF_3) is significantly less than that of (NH_3). Explain this observation in terms of orbital dipoles and lone pair effects.

18. Define the term Hybridization**.** Based on this concept, state the hybridization of the carbon atoms in ethyne (C_2H_2) and describe the types of bonds (sigma and pi) formed between them.

19. Draw the Lewis dot structure for the carbonate ion (CO_3^{2-}).

SHORT ANSWER TYPE QUESTIONS(3 Marks)

20. Using Molecular Orbital Theory (MOT), compare the bond orders of O_2,O_2^+ and O_2^-. Arrange them in increasing order of bond stability.

21. Predict and explain the shapes of SF_4 and BrF_5 using VSEPR theory. Indicate the number of bonding and lone pairs on the central atom in each case.

22. Explain the concept of Resonance. Illustrate your answer by drawing the resonating structures of the Nitrate ion (NO_3^-).

23. Draw the Lewis structures of the following: (i) CN^- (ii) NO_2^- (iii) O_3

LONG ANSWER TYPE QUESTIONS(5 Marks)

24.Using the Valence Shell Electron Pair Repulsion (VSEPR) theory, predict the geometry, the number of lone pairs on the central atom, and the approximate bond angles for the following molecules:

a) PCl_5
b) SF_6
c) ClF_3

25. Draw the Molecular Orbital (MO) energy level diagram for the nitrogen molecule (N_2). Calculate its bond order and explain its diamagnetic nature based on the diagram.

CASE STUDY QUESTIONS(4 Marks)

26. **Read the given passage and answer the questions given below:**

Molecular Orbital Theory (MOT) provides a sophisticated framework for understanding the electronic structure of molecules by considering the linear combination of atomic orbitals (LCAO). Unlike Valence

Bond Theory, which views electrons as localized between atoms, MOT treats electrons as being delocalized over the entire molecule in molecular orbitals. These orbitals are classified as bonding, anti bonding, or non-bonding based on their energy levels relative to the parent atomic orbitals.

One of the most significant triumphs of MOT is its ability to accurately predict the magnetic properties and bond orders of homonuclear diatomic molecules. For instance, the bond order—defined as half the difference between the number of electrons in bonding and antibonding orbitals—directly correlates with bond strength and inversely with bond length.

MOT famously explains the paramagnetic nature of the Oxygen molecule (O_2), which contains two unpaired electrons in its antibonding orbitals, a fact that Lewis structures fail to represent.Furthermore, the theory explains why N2 possesses a high bond order of 3, making it exceptionally stable, while F_2 has a bond order of 1.

1. Explain why the bond order of N_2 is higher than that of F_2. Explain in terms of Molecular orbital theory

2. Based on the passage, which of the following best explains why the bond length of O_2 increases when it is converted to the $\mathbf{O_2^-}$(superoxide) ion?

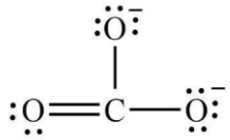
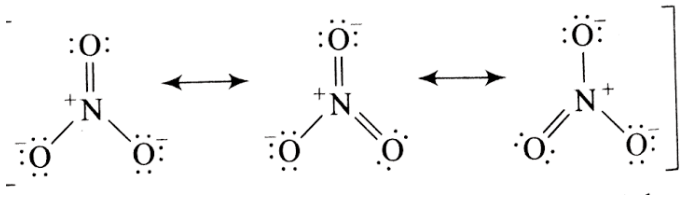
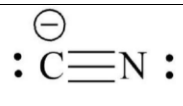
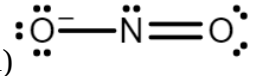
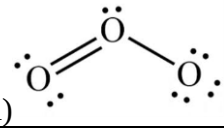
A) The number of bonding electrons increases, decreasing the bond order.
B) An electron is added to an antibonding orbital, decreasing the bond order.
C) The s-p mixing increases, causing the energy levels to shift.
D) The molecule becomes diamagnetic, which weakens the inter-nuclear attraction.

3. Predict the change in both the bond order and the magnetic property when a neutral Nitrogen molecule (N_2) is ionised to form the N_2^+cation. Justify your prediction using the MO electronic configuration.

4. Using Molecular Orbital Theory, calculate the bond order for the Helium molecule (He_2). Based on your calculation, explain why this molecule does not exist in nature.

Answers

Q.No	Answers
1.	B) The presence of a lone pair on nitrogen, which prevents the bond dipole from cancelling.
2	C) CH_4
3.	A) sp, sp^2sp^3
4.	C) Lone pair-lone pair repulsions in H_2O are greater than lone pair-bond pair repulsions in NH_3.
5.	B) H_2O
6.	A) octahedral geometry
7.	B) sp^3
8.	A) CN^-
9.	D) 0
10.	B) $H_2O > HF > NH_3$
11.	A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
12.	A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
13.	A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
14.	C) Assertion (A) is true but Reason (R) is false.

15.	C) Assertion (A) is true but Reason (R) is false.
16.	• Central O (1): 6-2-3=+1 • Double bonded O (2): 6-4-2=0 • Single bonded O (3): 6-6-1=-1
17.	In NH_3, the lone pair dipole and N-H bond dipoles are in the same direction (reinforcing). In NF_3, the lone pair dipole and N-F bond dipoles are in opposite directions (opposing).
18.	Intermixing of atomic orbitals of slightly different energies to form new equivalent orbitals. Ethyne: hybridization. Contains 1 sigma and 2 pi bonds between carbons.
19.	
20.	B.O. of O_2 = 2.0 B.O. of $O2^+$= 2.5 B.O. of O_2^-= 1.5 $O2^- < O_2 < O_2^+$
21.	SF_4 4 bp + 1 lp = See-saw shape BrF_5 5 bp + 1 lp = Square pyramidal shape
22.	Use of two or more Lewis structures to represent a single molecule. 
23.	(i)  (ii)  (iii) 

24.	PCl5 - 5 bp, 0 lp; Trigonal Bipyramidal;120^0 and 90^0 SF_6 6 bp, 0 lp; Octahedral; 90^0 ClF_5 3 bp, 2 lp; T-shaped ; $<90^0$
25.	$(\sigma_{1s})^2(\sigma^*_{1s})^2(\sigma_{2s})^2(\sigma^*_{2s})^2(\pi_{2p_x})^2(\pi_{2p_y})^2(\sigma_{2p_z})^2$ B.O. = $(10-4)/2 = 3$. Diamagnetic
26	1. N_2 has (14e-) 10 bonding and 4 antibonding electrons; Bond Order =3 F_2 has(18e-) 10 bonding and 8 antibonding electrons; Bond Order = 1 . 2. D) An electron is added to an antibonding orbital, decreasing the bond order. 3. When N_2(Bond Order = 3, diamagnetic) is converted to N_2^+(Bond Order = 2.5, paramagnetic), an electron is removed from a bonding orbital. This decreases the bond order and results in an unpaired electron. 4. He_2 has 4 electrons. Configuration is $(\sigma 1s)^2(\sigma^* 1s)^2$. Bond Order = 0. A bond order of zero indicates that the molecule is unstable and does not exist

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