

Chemical Bonding and Molecular Structure

Class 11 Chemistry · 24 NEET MCQs with answers & explanations

Chemical Bonding is one of NEET Chemistry's most important chapters. Lewis structures, VSEPR theory (molecular geometry), hybridisation, molecular orbital theory (MOT), bond order, hydrogen bonding and metallic bonding are all tested. Predicting shapes (linear, trigonal planar, tetrahedral, bent) from electron pairs is a NEET favourite.

Key Bonding Concepts

Concept	Key Fact
VSEPR shapes	2 bp = linear; 3 bp = trigonal planar; 4 bp = tetrahedral; 2 bp + 2 lp = bent
Hybridisation	sp = linear (180°), sp^2 = trigonal (120°), sp^3 = tetrahedral (109.5°)
Bond order (MOT)	$BO = (N_b - N_a)/2$; $BO = 0$ means molecule doesn't exist
Dipole moment	$\mu = q \times d$; linear symmetric molecules (CO_2 , BF_3) have $\mu = 0$ despite polar bonds
Hydrogen bonding	$F-H \cdots F > O-H \cdots O > N-H \cdots N$; intramolecular H-bond lowers boiling point
Resonance	Delocalisation of electrons; actual structure is hybrid of all contributing structures

Questions

Q1. The formal charge on the sulphur atom in the conventional Lewis representation of SO_3 is:

- (A) 0
- (B) 1
- (C) 2
- (D) 6

Q2. Among CH_4 , NH_3 and H_2O , which statement about their bond angles is correct?

- (A) $\angle H_2O > \angle NH_3 > \angle CH_4$
- (B) $\angle CH_4 > \angle NH_3 > \angle H_2O$
- (C) $\angle NH_3 > \angle CH_4 > \angle H_2O$
- (D) $\angle CH_4 > \angle H_2O > \angle NH_3$

Q3. In which of the following molecules does the central atom form a coordinate bond with one of the other atoms?

- (A) BF_3
- (B) CH_4
- (C) H_3O^+
- (D) NF_3

Q4. Which of the following molecules violates the octet rule?

- (A) CH_4
- (B) H_2O
- (C) NO
- (D) CO_2

Q5. Which process is essential for the formation of an ionic bond?

- (A) Complete electron transfer
- (B) Equal electron sharing
- (C) Lateral orbital overlap
- (D) Intermolecular hydrogen bonding

Q6. Which quantity measures the energy required to remove an electron from a gaseous atom in its ground state?

- (A) Electron gain enthalpy
- (B) Ionization enthalpy
- (C) Lattice enthalpy
- (D) Bond dissociation enthalpy

Q7. Which concept explains covalent bond formation through overlap of half-filled atomic orbitals?

- (A) Valence bond theory
- (B) Molecular orbital theory
- (C) VSEPR theory
- (D) Hybridization theory

Q8. Which type of orbital overlap results in the formation of a sigma bond?

- (A) Sidewise overlap of p orbitals
- (B) End-to-end (axial) overlap
- (C) Parallel overlap of p orbitals
- (D) Overlap of filled orbitals

Q9. Which observation about O_2 is explained by MOT but NOT by VBT?

- (A) Paramagnetic nature of O_2
- (B) Double bond in O_2
- (C) Bond length of O_2
- (D) High bond energy of O_2

Q10. Which type of molecular orbital is formed by constructive interference of atomic orbital wave functions?

- (A) Antibonding orbital
- (B) Bonding orbital
- (C) Non-bonding orbital
- (D) Hybrid orbital

Q11. Which parameter represents the average distance between the nuclei of two covalently bonded atoms?

- (A) Bond length
- (B) Bond angle
- (C) Bond enthalpy
- (D) Bond order

Q12. Which parameter is defined as the amount of energy required to break one mole of bonds in gaseous molecules?

- (A) Bond length
- (B) Bond enthalpy
- (C) Bond angle
- (D) Dipole moment

Q13. Which noble gas configuration does sodium attain upon losing an electron in NaCl, according to Kossel's approach?

- (A) Neon
- (B) Argon
- (C) Krypton
- (D) Xenon

Q14. The Lewis symbol of an element represents which type of electrons?

- (A) Core electrons only
- (B) Valence electrons only
- (C) Electrons in all orbitals
- (D) Only paired electrons

Q15. Which theory predicts molecular shape based on electron pair repulsion?

- (A) VSEPR theory
- (B) Valence bond theory
- (C) Molecular orbital theory
- (D) Crystal field theory

Q16. Which type of repulsion is strongest according to VSEPR theory?

- (A) Bonding pair-bonding pair
- (B) Lone pair-lone pair
- (C) Lone pair-bonding pair
- (D) Double bond-single bond

Q17. Hydrogen bonding is best classified as a special type of which interaction?

- (A) Dipole-dipole interaction
- (B) Ion-ion interaction
- (C) London dispersion force
- (D) Ion-dipole interaction

Q18. Which element forms the strongest hydrogen bond when covalently bonded to hydrogen?

- (A) Chlorine
- (B) Fluorine
- (C) Nitrogen
- (D) Oxygen

Q19. Which order of bond angle is correct?

- (A) $\text{NH}_3 > \text{NF}_3 > \text{PH}_3$
- (B) $\text{H}_2\text{O} > \text{NH}_3 > \text{CH}_4$
- (C) $\text{PH}_3 > \text{NH}_3 > \text{NF}_3$
- (D) $\text{NF}_3 > \text{NH}_3 > \text{PH}_3$

Q20. Which molecule contains one σ bond and two π bonds between the same pair of atoms?

- (A) O_2
- (B) H_2
- (C) Cl_2
- (D) N_2

Q21. Which of the following correctly represents the hybridisation of the central atom and molecular shape of H_2O ?

- (A) sp^2 , bent
- (B) sp^3 , bent
- (C) sp^3 , linear
- (D) sp^2 , linear

Q22. Which species has the highest bond order among the following?

- (A) N_2^+
- (B) N_2
- (C) O_2^-
- (D) O_2

Q23. Which of the following species does NOT obey the octet rule?

- (A) NH_3
- (B) H_2O
- (C) BF_3
- (D) CH_4

Q24. Which of the following correctly explains why noble gases are chemically inert?

- (A) They have high ionisation enthalpy
- (B) Their completely filled valence shells confer maximum stability
- (C) They have very large atomic radii
- (D) They do not participate in any bonding under any condition

Answer key

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

Answers with explanations

Q1 — Answer: (A) 0

The formal charge is $FC = V - N - B/2$. For S in the expanded-octet Lewis structure of SO_3 , $V = 6$, $N = 0$ and six bonding pairs contribute $B/2 = 6$, giving $FC = 0$. The trap is +2, which comes from an incomplete-bond representation.

Q2 — Answer: (B) $\angle CH_4 > \angle NH_3 > \angle H_2O$

The bond-angle order is CH_4 (109.5°) $>$ NH_3 (107°) $>$ H_2O (104.5°). Increasing lone-pair repulsion compresses the bond angle progressively. The trap options reverse or scramble this order.

Q3 — Answer: (C) H_3O^+

In H_3O^+ , the oxygen uses a lone pair to form a coordinate (dative) bond with H^+ , contributing both electrons. BF_3 and CH_4 involve normal covalent bonds; NF_3 has standard shared-pair bonds only.

Q4 — Answer: (C) NO

NO has 11 total electrons, making it an odd-electron molecule — the nitrogen atom cannot achieve a complete octet. CH_4 , H_2O , and CO_2 all satisfy the octet rule for their central atoms.

Q5 — Answer: (A) Complete electron transfer

Ionic bonds form by complete transfer of electrons from a metal to a non-metal, creating oppositely charged ions held by electrostatic attraction. Electron sharing defines covalent bonds, not ionic bonds. Orbital overlap and hydrogen bonding are unrelated to ionic bond formation.

Q6 — Answer: (B) Ionization enthalpy

Ionization enthalpy is the energy required to remove the outermost electron from a gaseous atom in its ground state. Electron gain enthalpy involves addition of an electron, not removal. Lattice enthalpy and bond dissociation enthalpy refer to crystal and bond energies respectively.

Q7 — Answer: (A) Valence bond theory

VBT proposes that a covalent bond forms when half-filled atomic orbitals of two atoms overlap, resulting in electron pairing and bond formation. MOT uses linear combination of orbitals rather than direct overlap. VSEPR predicts geometry but does not explain bond formation.

Q8 — Answer: (B) End-to-end (axial) overlap

Sigma bond forms by end-to-end (axial) overlap of orbitals along the internuclear axis, giving maximum overlap. Sidewise overlap of p orbitals forms a pi bond, not sigma. Only half-filled orbitals participate in bond formation under VBT.

Q9 — Answer: (A) Paramagnetic nature of O_2

MOT predicts two unpaired electrons in the degenerate π^*2p orbitals of O_2 , explaining its paramagnetism. VBT incorrectly predicts all electrons are paired (diamagnetic). Bond length and bond energy are explained by both theories.

Q10 — Answer: (B) Bonding orbital

Constructive interference (addition of wave functions) increases electron density between nuclei, forming a bonding molecular orbital of lower energy than the constituent atomic orbitals. Destructive interference forms antibonding orbitals.

Q11 — Answer: (A) Bond length

Bond length is defined as the equilibrium distance between nuclei of bonded atoms. Bond order affects bond length but is not the distance itself. Bond enthalpy measures energy, not distance.

Q12 — Answer: (B) Bond enthalpy

Bond enthalpy (bond dissociation enthalpy) is the energy needed to homolytically break one mole of a specific bond in gaseous state. Dipole moment measures polarity, not energy. Bond length is a distance parameter.

Q13 — Answer: (A) Neon

Sodium (atomic number 11) loses one electron to attain the configuration $1s^22s^22p^6$, identical to Neon. Argon (option B) is the configuration attained by chlorine in NaCl, not sodium — a common mix-up. This electron transfer is the central idea of Kossel's approach to ionic bond formation.

Q14 — Answer: (B) Valence electrons only

Lewis symbols represent only valence electrons, as these are involved in bonding. Core electrons (option A) are not shown because they do not participate in chemical bond formation. Paired and unpaired valence electrons are both shown as dots around the elemental symbol.

Q15 — Answer: (A) VSEPR theory

VSEPR (Valence Shell Electron Pair Repulsion) theory predicts molecular geometry by minimising repulsion between all electron pairs around the central atom. VBT explains bonding through orbital overlap, not shape prediction.

Q16 — Answer: (B) Lone pair-lone pair

Lone pair-lone pair repulsion is strongest because lone pairs are held by only one nucleus and occupy more space, exerting greater repulsive force. The repulsion order is: lp-lp > lp-bp > bp-bp.

Q17 — Answer: (A) Dipole-dipole interaction

Hydrogen bonding is an exceptionally strong dipole-dipole interaction where H bonded to F, O, or N acts as a partial positive centre attracting a lone pair on an electronegative atom. Ion-ion and ion-dipole interactions involve full charges, not partial ones. London forces are non-polar in origin.

Q18 — Answer: (B) Fluorine

Fluorine has the highest electronegativity (4.0) and smallest atomic size among all halogens and electronegative elements, creating the most polarised X-H bond and strongest H-bond. Chlorine, despite being electronegative, is too large — its diffuse electron cloud weakens H-bond formation.

Q19 — Answer: (A) $\text{NH}_3 > \text{NF}_3 > \text{PH}_3$

NH_3 has a bond angle of about 107° . In NF_3 , the highly electronegative F withdraws bonding electron density away from N, reducing bond-pair repulsion and compressing the angle to about 102.5° . PH_3 has far less hybridisation character, giving an angle of about 93.5° . Therefore $\text{NH}_3 > \text{NF}_3 > \text{PH}_3$.

Q20 — Answer: (D) N_2

The $\text{N}\equiv\text{N}$ triple bond in N_2 consists of one head-on σ bond and two lateral π bonds formed by sideways overlap of p orbitals. O_2 has a double bond ($1\sigma + 1\pi$). H_2 and Cl_2 have single bonds containing only one σ bond each.

Q21 — Answer: (B) sp^3 , bent

Oxygen has two bond pairs and two lone pairs giving steric number 4 and sp^3 hybridisation. The electron-pair geometry is tetrahedral while the molecular geometry is bent.

Q22 — Answer: (B) N_2

N_2 has bond order 3, the highest among these species. N_2^+ has 2.5, O_2 has 2 and O_2^- has 1.5. Bond order = (bonding electrons minus antibonding electrons) divided by 2.

Q23 — Answer: (C) BF_3

BF_3 has only 6 electrons around boron (three bonding pairs), making it an electron-deficient species with an incomplete octet. NH_3 and H_2O both satisfy the octet around nitrogen and oxygen respectively. CH_4 also completes carbon's octet through four bonding pairs.

Q24 — Answer: (B) Their completely filled valence shells confer maximum stability

Completely filled valence shells (ns^2np^6) place noble gases at the lowest possible energy state, leaving no tendency to gain or lose electrons. High ionisation enthalpy (option A) explains resistance to cation formation but not overall inertness. Option D is factually incorrect — noble gases do form compounds (e.g., XeF_2) under certain conditions.

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