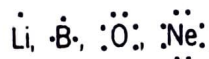


VERY SHORT ANSWER TYPE QUESTIONS

- How many electrons are present in a sextet and in an octet ?
- How many valence electrons do the atoms represented by following Lewis structures possess ?



- Draw the Lewis symbols of the following elements.

Na, Ca, Br, Xe, As, Ge

- Draw the Lewis structures for the following molecules and ions and tell which do not follow the octet rule.

F_2 , PH_3 , H_2S , SiCl_4 , C_3H_8 , F_2O , Na^+ , Cl^-

- What type of force does exist between two atoms in an ionic bond ?

- Short out the most and the least electronegative atoms among the following :

Cl, Na, O, N, S, F, Cs

- What type of bonds are expected to be formed between atoms having electronegativity difference

(i) equal to zero; (ii) equal to 1.1;
(iii) equal to 2.0.

- Which property of water is helpful in the dissolution of an ionic solid in it ?

- Why are the noble gases monoatomic ?

- Define bond energy.

- Among NH_3 and PH_3 which is expected to have a higher dipole moment and why ?

- Do van der Waals' forces exist between the atoms of noble gases ?

- What is octet rule ?

- What do you understand by lattice energy ?

- The elements of which groups prefer to form cations ?

- Do elements of groups 1 and 2 show variable electrovalency ?

- Do ionic solids conduct electric current in the solid state ?

- Define a covalent bond.

- How many covalent bonds are present in a molecule of ethylene ?

- Which of the following elements does not show variable covalency ?

Al, P, S, Cl

- What is the maximum covalency of sulphur ?

- How many singlet linkages are present in the Sugden's structure of SF_6 ?

- When does a covalent bond acquire partial ionic character ?

- When does an ionic bond develop a partial covalent character ?

- Among AgCl and AgI , which is more covalent ?

- Can a π -bond be formed without the formation of a σ -bond ?

- What type of orbitals can overlap to form a covalent bond ?

- What happens to the potential energy of the system when two atoms form a covalent bond ?

- Is hybridisation between the orbitals of two atoms possible ?

- What type of bond is formed when two p -orbitals overlap axially ?

- How many σ and π bonds are present in $\text{CH}_3\text{—CH=CH}_2$?

- How much s and p characters are present in sp^3 hybrid orbitals ?

- What type of hybridisation do you expect in the following molecules ?

BF_3 , CH_4 , C_6H_6 , BeF_2 .

- In what respect a coordinate covalent bond is different from a covalent bond ?

- Illustrate the formation of H_3O^+ .

- What is a kernel and how is it formed ?

- Does the presence of intermolecular hydrogen bonding affect the boiling point of a liquid ?

- Why are the molecular orbitals regarded as polycentric ?

- Among σ_{2s} and σ_{2s}^* molecular orbitals, which one is of lower energy ?

- If ψ_A and ψ_B are the wave functions of two combining hydrogen atoms, what would be the wave functions of bonding and antibonding molecular orbitals formed by their combination ?

- What is the probability of finding electrons between the nuclei of the combining atoms in an antibonding molecular orbital ?

- For a molecule, $N_b = N_a$, will the molecule be stable ?

- How is bond length related to the bond order of the molecule ?

- The bond order of He_2^+ ion is $\frac{1}{2}$. Comment on its magnetic nature.

- What for does KK stand in the molecular orbital electronic configuration $\text{KK}(\sigma_{2s})^2$ for Li_2 molecule ?

- According to the molecular orbital theory, how many unpaired electrons are present in a O_2 molecule ?

- Carbon atom possesses only two unpaired electrons. How is it able to show tetravalency ?

- What are the hybrid states of C atoms in alkanes, alkenes and alkynes ?

SHORT ANSWER TYPE QUESTIONS

- Why do atoms combine together and form molecules ?
- What types of bonds will be formed between the following pairs of elements and why ?
 - K, Cl
 - Ca, S
 - N, H
 - C, O
- What is lattice energy and how is it related to the stability of an ionic compound ?
- Define Electronegativity. How does it vary in the periodic table ?
- Deduce the empirical formulae and draw the Lewis structures for the ionic compounds formed by the following pairs of elements.

Na, O;	K, S;	Na, P;	Mg, Br;	Al, F;
Ca, O;	Li, S			
- Three elements have the following Lewis symbols.

$$\begin{array}{c} \bullet \\ \text{A} \cdot \text{B} \cdot \\ \bullet \end{array} \quad \begin{array}{c} \bullet \\ \text{C} \\ \bullet \\ \bullet \\ \bullet \\ \bullet \end{array}$$

 - Place the elements in the appropriate groups of the periodic table.
 - Which elements are likely to form ions ? What is the expected charge on ions ?
 - Write the formulae and the Lewis structures of the covalent compounds formed between
 - A and B ,
 - A and C.
- Explain why ionic compounds
 - possess high melting and boiling points;
 - are soluble in water;
 - are hard and brittle.
- Why do covalent compounds exhibit stereoisomerism ?
- What do you understand by bond length ? On what factors does it depend ?
- Carbon possesses only two unpaired electrons in its valence shell. How does it show a covalency equal to four in most of its compounds ?
- Why does a covalent bond develop a partial ionic character when the electronegativities of the combining atoms are different ?
- You are given five neutral atoms A, B, C, D and E having the following electronic configuration :

A— $1s^2 2s^2 2p^6 3s^2$,	B— $1s^2 2s^2 2p^6 3s^1$,	C— $1s^2 2s^2 2p^1$,
D— $1s^2 2s^2 2p^5$,	E— $1s^2 2s^2 2p^6$	

 Write the empirical formulae for the substances containing :
 - A and D
 - B and D
 - only D
 - only E.
- Why is ionic bond regarded as an extreme case of a polar covalent bond ?
- Define bond energy. On what factors does it depend ?
- Discuss the formation of MgO.
- Discuss the factors which govern the formation of an ionic bond.
 - What do you understand by variable electrovalency ? Give some examples.
 - What is inert pair effect ? How does it account for the variable electrovalency of the elements having configuration of the type $ns^2 np^{1-4}$.
 - What is Born-Haber cycle ? Explain with an example.
 - Discuss the factors which govern the formation of a covalent bond.
 - What is variable covalency ? Give some examples.
 - What are Sidgwick's views regarding the failure of the octet rule ?
 - What are Fajan's rules ?
 - Define dipole moment. How is it related to the molecular structure ?
 - Write the resonating structures of O₃ and CO₂.
 - What is lattice energy and how is it related to the stability of an ionic compound ?
 - Why do covalent compounds exhibit stereoisomerism ?
 - On the basis of VSEPR theory explain why BeCl₂ molecule is linear whereas H₂O is angular.
 - What type of forces come into action when two atoms approach each other ?
 - Discuss how the Valence bond theory explains the pyramidal shape of NH₃ molecule.
 - Explain the difference between a σ and a π-bond.
 - Draw the shapes of sp³, sp² and sp hybrid orbitals.
 - Out of σ and π-bonds, which bond is stronger and why ?
 - Why are the molecules like He₂, H₃ and H₄ not formed ?
 - What do you understand by bond length ? On what factors does it depend ?
 - Carbon possesses only two unpaired electrons in its valence shell. How does it show a covalency equal to four in most of its compounds ?
 - Why is hybridisation of atomic orbitals necessary for the formation of a molecule ? Illustrate your answer by taking the example of CH₄.
 - Why is a molecule involving sp² hybridisation trigonal and planar ?
 - Explain how the Valence bond theory accounts for a carbon-carbon double bond.
 - Explain the formation of C₂H₂ molecule.
 - Explain why the compounds of the type C₂H₂X₂ exhibit cis-trans isomerism.
 - Why does a covalent bond develop a partial ionic character when the electronegativities of the combining atoms are different ?
 - How do the metals conduct heat and electricity ?

44. Explain why
- * (i) metals are malleable and ductile;
 - * (ii) sodium can be cut with a knife;
 - * (iii) H_2O is a liquid while H_2S is a gas;
 - * (iv) o-nitrophenol possesses low boiling point in spite of the presence of hydrogen bonding in it.
45. What do you understand by overlap integral and what does it signify ?
46. State the salient features of molecular orbital theory.
47. What are the main points of difference between atomic and molecular orbitals ?
48. What do you understand by linear combination of atomic orbitals ?
49. Explain why a bonding molecular orbital is of low energy while an antibonding molecular orbital of high energy.
50. What are the main points of difference between bonding and antibonding molecular orbitals ?
51. What are the main points of difference between σ and π orbitals ?
52. Give the molecular orbital description of hydrogen molecule and deduce the bond order.
53. Distinguish two aspects of bonding and antibonding molecular orbitals.
54. Describe molecular orbital. How is it different from an atomic orbital ?
55. Why does He_2 not exist ?
56. What do you understand by bond order and what does it signify ?
57. Why is bond order in H_2^- less than that in H_2 ?
58. Explain on the basis of molecular orbital diagram why O_2 should be paramagnetic.
59. Using molecular orbital diagram, arrange the following molecular species in the increasing order of their stabilities :
- H_2, H_2^+ and H_2^- .
60. Which of the following species are paramagnetic ?
- * H_2, H_2^+ and H_2^- .
61. With the help of molecular orbital approach show the Ne_2 cannot exist as a stable species.
62. Arrange the following molecular species in increasing order of stability (giving bond orders) :
- $O_2, O_2^+, O_2^-, O_2^{2-}$
63. What are the main points of difference between valence bond and molecular orbital theories ?
64. Depict molecular orbital diagrams of N_2^+ and He_2^+ and predict which one of the two species will be more stable.
65. Define hybridisation.
66. Give reason for the following :
Bond order in N_2 is 3 whereas it is 2.5 in NO .

ESSAY (LONG ANSWER) TYPE QUESTIONS

1. What is an ionic bond and how is it formed ? Illustrate your answer by atleast two examples. What are the factors which govern the formation of an ionic bond ? Mention the main characteristics of ionic compounds.
2. Define a covalent bond. Explain the formation of Cl_2 , NH_3 , O_2 and PCl_3 molecules. How does the multiplicity of bonds affect the bond length and bond energy ?
3. What is octet rule ? Is it followed by all molecules ? What type of exceptions have been observed to this rule ? Illustrate your answer with examples.
4. What do you understand by partial ionic character in a covalent bond ? Give at least three examples of the compounds containing partially ionic covalent bonds.
5. What is dipole moment ? How is it helpful in deciding the geometry of a molecule ?
6. Explain why :
 - (i) The dipole moment of CO_2 is zero although it contains electronegative oxygen atoms.
 - (ii) Both BF_3 and NH_3 are the molecules of the type AB_3 but their dipole moments are not equal.
- * (iii) dipole moment of H_2O is much higher than that of H_2S .
7. What is lattice energy and how can it be calculated with the help of Born-Haber cycle? Illustrate with an example.
8. What is variable electrovalency and why do elements show it? Explain with examples.
9. What do you understand by covalency, variable covalency and maximum covalency ? Explain the variable covalencies exhibited by phosphorus and chlorine.
10. Compare the important properties of ionic and covalent compounds.
11. Give some examples which illustrate the failure of the octet rule. What explanations have been suggested to explain the failure of the octet rule ?
12. Explain with examples the cause of partial ionic character in covalent bonds.
13. Why do certain ionic compounds exhibit partial covalent character ? Explain with examples.
14. What do you understand by polarisation ? State and explain Fajan's rules.

15. Define resonance and resonance energy. What are the conditions for resonance? Explain the structures of NO_3^- and CO_3^{2-} ions on its basis.
16. State and explain the main postulates of VSEPR theory. How is this theory helpful in explaining the geometry of the following molecules? BeF_2 , NH_3 , H_2O , PCl_5 and SF_6 .
17. State and explain the main postulates of Valence bond theory. How does this theory explain the shapes of the following molecules?
HF, N_2 , H_2S and PH_3 .
18. What do you understand by overlapping of orbitals? Explain the overlapping of s and p-orbitals. What are sigma and pi-bonds and what is the main difference between them?
19. What do you understand by hybridisation? Explain with examples the various types of hybridisation involving s and p-orbitals.
20. What is a coordinate covalent bond and how is it formed? Write the Lewis structures of the following molecules:
 O_3 , SO_2 , SO_3 , H_2SO_4 and NH_4^+ .
21. What do you understand by partial ionic character in a covalent bond? Give at least three examples of the compounds containing partially ionic covalent bonds.
22. What is dipole moment? How is it helpful in deciding the geometry of a molecule?
23. What are the van der Waals' forces and how do they come into existence between the molecules? Mention the characteristics of the solids possessing these forces between their constituent species.
24. What type of bonding exists in metallic solids? Describe electron sea model and elaborate how this model explains the specific properties of metals.
25. What is hydrogen bonding and what are the conditions which favour its formation? What is the effect of hydrogen bonding on the properties of the substances? Illustrate your answer with examples.
26. Describe the salient features of valence bond theory. Explain the formation of H_2 molecule on the basis of this theory.
27. Describe the main features of Molecular orbital theory.
28. How is a molecular orbital different from an atomic orbital? Give the number of electrons which occupy the bonding molecular orbitals in H_2^- and H_2 .
29. What is LCAO method? How does it lead to the concept of bonding and antibonding molecular orbitals? What are the main points of difference between bonding and antibonding molecular orbitals?
30. What do you understand by an energy level diagram? Show the molecular orbitals formed by overlapping of 1s-, 2s- and 2p- atomic orbitals on an energy level diagram.
31. What is bond order? How is it obtained from a MO diagram? Discuss the information conveyed by bond order for a molecule.
32. Draw the molecular orbital diagrams of H_2 , H_2^+ and H_2^- and discuss their relative stabilities.
33. On the basis of molecular orbital theory, explain why He_2 does not exist whereas He_2^+ exists?
34. Draw the molecular orbital diagram of N_2 molecule and write its molecular orbital configuration. Calculate the bond order and discuss the extra stability and diamagnetic nature of the molecule.
35. Draw the molecular orbital diagram of O_2 molecule. How would you explain the paramagnetic nature of the molecule on the basis of this diagram?
36. What are the conditions of combination of atomic orbitals? Which species out of H_2 , H_2^+ and H_2^- are paramagnetic and why?
37. Write the molecular orbital configuration of O_2 , O_2^+ , O_2^- and O_2^{2-} species and compare their characteristics.
38. Mention the main points of similarities and differences between valence bond and molecular orbital theories.
39. What do you understand by hybridisation? Discuss the need and rules of hybridisation.
40. Explain:
(i) The bond angle in methane is $109^\circ 28'$.
(ii) Ethene is a planar molecule.
(iii) Ethyne is a linear molecular.
41. N_2 has greater bond energy than N_2^+ but O_2 has lower bond dissociation energy than O_2^+ . Explain.

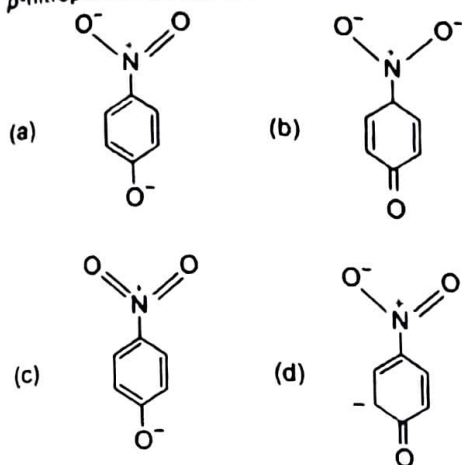
OBJECTIVE (MULTIPLE CHOICE) TYPE QUESTIONS

Choose the correct option in the following questions:

- During the formation of a chemical bond potential energy of the system:
 - increases
 - decreases
 - neither increases nor decreases
 - remains constant.
- In a crystal cations and anions are held together by:
 - electrons
 - electrostatic forces
 - nuclear forces
 - covalent bonds.
- Which of the following contains both covalent and ionic bonds?
 - CCl_4
 - CaCl_2
 - NH_4Cl
 - H_2O
- In which of the following ionic, covalent and coordinate bonds are present?
 - Water
 - Ammonia
 - Sodium
 - Potassium bromide
- NH_3 and BF_3 form an adduct readily because they form:
 - a coordinate bond
 - a covalent bond
 - an ionic bond
 - a hydrogen bond.
- The total number of electrons that take part in forming bonds in N_2 is:
 - 2
 - 4
 - 6
 - 10.
- KCl readily dissolves in water because:
 - it is a salt of K
 - it reacts with water
 - it is an electrovalent compound
 - its ions are easily solvated.
- Which of the following is least ionic?
 - AgCl
 - KCl
 - BaCl_2
 - CoCl_2 .

9. A bond with maximum covalent character between non-metallic elements is formed :
 (a) between atoms of same size
 (b) between chemically similar atoms
 (c) between identical atoms
 (d) between atoms of widely different .
10. Element X is strongly electropositive and element Y is strongly electronegative. Both are univalent. The compound formed would be :
 (a) $X^+ Y^-$ (b) $X^- Y^+$
 (c) $X-Y$ (d) $X \rightarrow Y$
11. Which of the following formula does not correctly represent the bonding capacity of the atom involved ?
 (a) $\left[\begin{array}{c} \text{H} \\ | \\ \text{H}-\text{P}-\text{H} \\ | \\ \text{H} \end{array} \right]^+$ (b) $\text{F}-\text{O}-\text{F}$
 (c) $\text{O} \leftarrow \text{N} \begin{array}{l} \text{O} \\ \text{O}^- \end{array}$ (d) $\text{H}-\text{C}-\text{C} \begin{array}{l} \text{O} \\ \text{O}-\text{H} \end{array}$
12. Which one of the following molecules contain one lone pair of electrons on the central atom ?
 (a) CH_4 (b) NH_3
 (c) CCl_4 (d) H_2O
13. If the electron pair forming a bond between two atoms A and B is not in the centre, then the bond is :
 (a) single bond (b) polar bond
 (c) non-polar bond (d) π -bond.
14. Energy required to dissociate 4 g of gaseous hydrogen into free gaseous atoms is 208 k cal at 25°C. The bond energy of H—H bond will be :
 (a) 104 k cal (b) 10.4 k cal
 (c) 1040 k cal (d) 1.04 k cal.
15. The molecule which does not exhibit is :
 (a) NH_3 (b) CHCl_3
 (c) H_2O (d) CCl_4 .
16. Which bond angle θ would result in the maximum dipole moment for the triatomic molecule YXY ?
 (a) $\theta = 90^\circ$ (b) $\theta = 120^\circ$
 (c) $\theta = 150^\circ$ (d) $\theta = 180^\circ$.
17. The table shown lists the bond dissociation energies (E_{diss}) for single covalent bonds formed between carbon and atoms of elements A, B, C and D. Which element has the smallest atom ?
- | Bond between | E_{diss} (kJ mol ⁻¹) |
|--------------|------------------------------------|
| C and atom | |
| C—A | 240 |
| C—B | 328 |
| C—C | 276 |
| C—D | 485 |
- (a) C (b) D
 (c) A (d) B.
18. Which one of the following molecules does not possess a permanent electric dipole moment ?
 (a) H_2S (b) SO_2
 (c) CS_2 (d) SO_3
19. Carbon suboxide (C_3O_2) has recently be shown as a component of the atmosphere of venus. Which of the following formulations represent the correct ground state Lewis structure for carbon suboxide ?
 (a) $:\ddot{\text{O}} : \text{C} :: \text{C} : \text{C} :: \ddot{\text{O}} :$
 (b) $:\text{O} :: \text{C} : \text{C} : \text{C} : \text{C} :: \text{O} :$
 (c) $:\ddot{\text{O}} :: \text{C} :: \text{C} :: \text{C} :: \ddot{\text{O}} :$
 (d) $:\text{O} : \text{C} : \text{C} : \text{C} : \text{O} :$
20. Which of the following is planar ?
 (a) SiCl_4 (b) NF_3
 (c) SF_4 (d) XeF_4 .
21. Resonance structures of a molecule should not have :
 (a) identical arrangement of atoms
 (b) nearly the same energy content
 (c) same number of unpaired electrons
 (d) different number of unpaired electrons.
22. The dipole moment of NF_3 is much less as compared to that of NH_3 because :
 (a) the size of N atom is much less than that of H atom
 (b) F atom is more electronegative than N atom, whereas H atom is less electronegative than N atom
 (c) unshared electron pair is not present in NF_3
 (d) number of lone pairs in NF_3 is much greater than in NH_3
23. Which does not have zero value of dipole moment ?
 (a) $[\text{Ni}(\text{CN})_4]^{2-}$ (b) CHCl_3
 (c) CO_2 (d) $\text{Cl}-\text{C}_6\text{H}_4-\text{Cl}$.
24. Which of the following conditions does not apply to resonating structures ?
 (a) The contributing structures should have the same or nearly same energies.
 (b) The contributing structures should be represented such that unlike charges reside on the atoms which are the farthest.
 (c) The electropositive atom should have positive charge and the electronegative atom the negative charge.
 (d) The contributing structures must have the same number of unpaired electrons.
25. Resonance occurs due to :
 (a) delocalisation of lone pair of electrons
 (b) delocalisation of σ -electrons
 (c) delocalisation of π -electrons
 (d) oscillation of a proton.
26. Which of the following is not the characteristic of a white phosphorus (P_4) molecule ?
 (a) Presence of six P-P single bonds
 (b) Presence of four P-P single bonds
 (c) Presence of four lone pairs of electrons
 (d) Presence of PPP angle of 60° .

27. The most unlikely representation of resonance structures of *p*-nitrophenoxide ion is :



[I.I.T., 1999]

28. The correct order of increasing C—O bond length of CO, CO₃²⁻, CO₂ is :

- (a) CO₃²⁻ < CO₂ < CO (b) CO₂ < CO₃²⁻ < CO
(c) CO < CO₃²⁻ < CO₂ (d) CO < CO₂ < CO₃²⁻

[I.I.T., 1999]

29. The geometry of H₂S and its dipole moment are :

- (a) angular and non-zero (b) angular and zero
(c) linear and non-zero (d) linear and zero. [I.I.T., 1999]

30. Which one of the following pairs of molecules will have permanent dipole moments for both members ?

- (a) SiF₄ and NO₂ (b) NO₂ and CO₂
(c) NO₂ and O₃ (d) SiF₄ and CO₂

[A.I.E.E.E., 2003]

31. Which one of the following groupings represents a collection of isoelectronic species ?

(At. numbers : Cs-55, Br-35)

- (a) Na⁺, Ca²⁺, Mg²⁺ (b) N³⁻, F⁻, Na⁺
(c) Be, Al³⁺, Cl⁻ (d) Ca²⁺, Cs⁺, Br

[A.I.E.E.E., 2003]

32. Which one of the following sets of ions represents the collection of isoelectronic species?

- (a) K⁺, Ca²⁺, Sc³⁺, Cl⁻ (b) Na⁺, Ca²⁺, Sc³⁺, F⁻
(c) K⁺, Cl⁻, Mg²⁺, Sc³⁺ (d) Na⁺, Mg²⁺, Al³⁺, Cl⁻

(Atomic numbers : F = 9, Cl = 17, Na = 11, Mg = 12, Al = 13, K = 19, Ca = 20, Sc = 21) [A.I.E.E.E., 2004]

33. Lattice energy of an ionic compound depends upon :

- (a) charge on the ion and size of the ion
(b) packing of ions only
(c) size of the ion only
(d) charge on the ion only. [A.I.E.E.E., 2005]

34. The molecular shapes of SF₄, CF₄ and XeF₄ are :

- (a) different with 1, 0 and 2 lone pairs of electrons on the central atom, respectively
(b) different with 0, 1 and 2 lone pairs of electrons on the central atom, respectively
(c) the same with 1, 1 and 1 lone pair of electrons on the central atom, respectively
(d) the same with 2, 0 and 1 lone pairs of electrons on the central atom, respectively. [A.I.E.E.E., 2005]

35. Of the following sets which one does not contain isoelectronic species ?

- (a) BO₃³⁻, CO₃²⁻, NO₃⁻ (b) SO₃²⁻, CO₃²⁻, NO₃⁻
(c) CN⁻, N₂, C₂²⁻ (d) PO₄³⁻, SO₄²⁻, ClO₄⁻

[A.I.E.E.E., 2005]

36. Which of the following molecules/ions does not contain unpaired electrons ?

- (a) O₂²⁻ (b) B₂
(c) N₂⁺ (d) O₂. [A.I.E.E.E., 2006]

37. Which one of the following sets of ions represents a collection of isoelectronic species ?

- (a) K⁺, Cl⁻, Ca²⁺, SC³⁺ (b) Ba²⁺, Sr²⁺, K⁺, S²⁻
(c) N³⁻, O²⁻, F⁻, S²⁻ (d) Li⁺, Na⁺, Mg²⁺, Ca²⁺

[A.I.E.E.E., 2006]

38. In which of the following molecules/ions all the bonds are not equal ?

- (a) SF₄ (b) SiF₄
(c) XeF₄ (d) BF₄ [A.I.E.E.E., 2006]

39. In which of the following ionisation processes, the bond order has increased and the magnetic behaviour has changed ?

- (a) C₂ → C₂⁺ (b) NO → NO⁺
(c) O₂ → O₂⁺ (d) N₂ → N₂⁺

[A.I.E.E.E., 2007]

40. Which of the following species exhibits the diamagnetic behaviour ?

- (a) O₂²⁻ (b) O₂⁺
(c) O₂ (d) NO. [A.I.E.E.E., 2007]

41. The calculated bond order of O₂⁻ is :

- (a) 2.5 (b) 2.0
(c) 1.5 (d) 1.0.

42. Which of the following is paramagnetic ?

- (a) O₂⁻ (b) CN⁻
(c) CO (d) NO⁺

43. Which one of the following compounds has sp² hybridisation?

- (a) CO₂ (b) SO₂
(c) N₂O (d) CO

[I.I.T., 1997]

44. The calculated bond order in H₂⁺ ion is :

- (a) 0 (b) $\frac{1}{2}$
(c) $-\frac{1}{2}$ (d) 1.

45. The bond order in the species O₂, O₂⁺ and O₂⁻ follows the order :

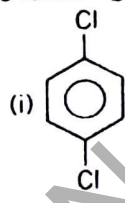
- (a) O₂ > O₂⁺ > O₂⁻ (b) O₂⁺ > O₂ > O₂⁻
(c) O₂⁻ > O₂ > O₂⁺ (d) O₂⁺ > O₂⁻ > O₂

46. Which of the following molecular orbitals has the lowest energy ?

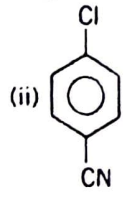
- (a) σ_{2p_x} (b) π_{2p_y}
(c) σ_{2p_x} (d) σ_{2s}

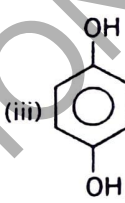
47. Among the following compounds the one that is polar and has the central atom with sp² hybridisation is :

- (a) H₂CO₃ (b) SiF₄
(c) BF₃ (d) HClO₂. [I.I.T., 1997]

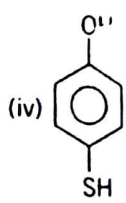
48. Oxygen molecule shows the property of :
 (a) diamagnetism (b) ferromagnetism
 (c) paramagnetism (d) none of these.
49. Which has the bond order $\frac{1}{2}$?
 (a) O_2 (b) N_2
 (c) F_2 (d) H_2
50. Which of the following is not a linear molecule ?
 (a) CO_2 (b) C_2H_2 (C.P.M.T., 1991)
 (c) HCN (d) H_2O .
51. Ammonia molecule is formed by the following hybrid orbitals:
 (a) dsp^2 (b) sp^3
 (c) $sp^3 d$ (d) $d^2 sp$. (M.P.P.M.T., 1993)
52. Which of the following is diamagnetic ?
 (a) O_2^+ (b) O_2
 (c) O_2 (d) O_2^2 .
53. If a molecule MX_3 has zero dipole moment, the sigma bonding orbitals used by M are :
 (a) pure p (b) sp hybrids
 (c) sp^2 hybrids (d) sp^3 hybrids.
54. Molecule in which the distance between two adjacent carbon atoms is the largest, is :
 (a) benzene (b) ethyne
 (c) ethene (d) ethane.
55. The bond order in F_2 molecule is :
 (a) 0 (b) 1
 (c) 2 (d) 3.
56. In which of the following pairs of molecules/ions, the central atoms have sp^2 hybridisation?
 (a) NO_2 and NH_3 (b) BF_3 and NO_2^-
 (c) NH_2^- and H_2O (d) BF_3 and NH_2^- (A.I.P.M.T., 2010)
57. Which one of the following species does not exist under normal conditions?
 (a) Be_2^+ (b) Be_2
 (c) B_2 (d) Li_2 (A.I.P.M.T., 2010)
58. Which of the following species contains three bond pairs and one lone pair around the central atom?
 (a) H_2O (b) BF_3
 (c) NH_2^- (d) PCl_3 (A.I.P.M.T., 2012)
59. Which of the following molecules has the maximum dipole moment?
 (a) CO_2 (b) CH_4
 (c) NH_3 (d) NF_3 (A.I.P.M.T., 2014)
60. Which of the following organic compounds has hybridisation as its combustion product $-(CO_2)$:
 (a) Ethane (b) Ethyne
 (c) Ethene (d) Ethanol (A.I.P.M.T., 2014)
61. The correct statement for the molecule CsI_3 is :
 (a) It is a covalent molecule
 (b) It contains Cs^+ and I_3^-
 (c) It contains Cs^{3+} and I^- ions
 (d) It contains Cs^+ , I^- and lattice I_2 molecule (J.E.E. Main, 2014)
62. For which of the following molecule significant $\mu \neq 0$?
- 

(i)



(ii)
- 

(iii)



(iv)
- (a) Only (i) (b) (i) and (ii)
 (c) Only (iii) (d) (iii) and (iv) (J.E.E. Main, 2014)
63. Which one of the following molecules is expected to exhibit diamagnetic behaviour?
 (a) C_2 (b) N_2
 (c) O_2 (d) S_2 (J.E.E. Main, 2013)
64. In which of the following pairs of molecules/ions both the species are not likely to exist?
 (a) H_2^+ , He_2^{2-} (b) H_2^- , He_2^{2-}
 (c) H_2^{2+} , He_2 (d) H_2^- , He_2^{2+} (J.E.E. Main, 2013)
65. Among the following, the maximum covalent character is shown by the compound :
 (a) $FeCl_2$ (b) $SnCl_2$
 (c) $AlCl_3$ (d) $MgCl_2$ (A.I.E.E.E., 2011)
66. The hybridization of orbitals of N atom in NO_3^- , NO_2^+ and NH_4^+ are respectively :
 (a) sp, sp^2 , sp^3 (b) sp^2 , sp, sp^3
 (c) sp, sp^3 , sp^2 (d) sp^2 , sp^3 , sp (A.I.E.E.E., 2011)
67. The number of types of bonds between two carbon atoms in calcium carbide is :
 (a) one sigma, two pi (b) one sigma, one pi
 (c) two sigma, one pi (d) two sigma, two pi (A.I.E.E.E., 2011)

Answers

- | | | | | | | | | | |
|---------|---------|------------|---------|---------|---------|---------|---------|---------|---------|
| 1. (b) | 2. (b) | 3. (c) | 4. (c) | 5. (a) | 6. (c) | 7. (d) | 8. (a) | 9. (c) | 10. (a) |
| 11. (d) | 12. (b) | 13. (b) | 14. (a) | 15. (d) | 16. (a) | 17. (b) | 18. (c) | 19. (c) | 20. (d) |
| 21. (d) | 22. (b) | 23. (b) | 24. (b) | 25. (c) | 26. (b) | 27. (c) | 28. (d) | 29. (a) | 30. (c) |
| 31. (b) | 32. (a) | 33. (a) | 34. (a) | 35. (b) | 36. (a) | 37. (a) | 38. (a) | 39. (b) | 40. (a) |
| 41. (c) | 42. (a) | 43. (b) | 44. (b) | 45. (b) | 46. (d) | 47. (a) | 48. (c) | 49. (d) | 50. (d) |
| 51. (b) | 52. (d) | 53. (c) | 54. (d) | 55. (b) | 56. (b) | 57. (b) | 58. (d) | 59. (c) | 60. (b) |
| 61. (b) | 62. (d) | 63. (a, b) | 64. (c) | 65. (c) | 66. (b) | 67. (a) | | | |

'TRUE OR FALSE' TYPE QUESTIONS

GPLUS EDUCATION

State whether the following statements are True (T) or False (F) :

- The formation of a chemical involves an increase in the potential energy of the system.
- Helium possesses an octet.
- Only the unpaired electrons present in the outermost shell of an atom are called valence electrons.
- An ionic bond is formed when the electronegativity difference in the combining atoms is more than 2.
- A higher value of ionisation energy of the electropositive atom favours the formation of an ionic bond.
- An ionic compound conducts electricity even in the solid state due to the presence of ions.
- In Cl_2 molecule, each Cl atom contains only one lone pair of electrons.
- O_2 molecule is paramagnetic in nature.
- Covalent compounds possess very high melting and boiling points.
- Ionic reactions are much faster than the molecular reactions.
- The bond length in H_2 molecule is 0.174 \AA .
- The bond length of $\text{C} \equiv \text{C}$ bond is greater than that of $\text{C}=\text{C}$ bond.
- Atoms A and B with Lewis structures $\cdot\cdot\cdot\text{A}\cdot\cdot\cdot$ and $\cdot\cdot\cdot\text{B}\cdot\cdot\cdot$ can form a singlet linkage.
- Dipole moment is a scalar quantity and is given by $m = q \times r$.
- All molecules with polar bonds have dipole moment.
- The repulsive interaction between two lone pairs is less than that between two bond pairs.
- π molecular orbital always contains a nodal plane which divides the orbital into two halves.
- The orbitals of an atom having large difference in energy cannot take part in hybridisation.
- Noble gases are soluble in water due to dipole induced dipole interaction.
- The mobile electrons in a metal occupy specified positions in the lattice and are not delocalised.
- A bonding molecular orbital is formed when the electron waves of the combining atoms are in phase.
- In a bonding molecular orbital, the electron density is almost zero between the nuclei of the combining atoms.
- The maximum number of electrons that can be accommodated in a molecular orbital is two.
- H_2^+ ion contains one electron in bonding and one in antibonding molecular orbitals.
- For N_2 molecule, $N_b = 8$ and $N_a = 2$.

Answers

- | | | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. F | 2. F | 3. F | 4. T | 5. F | 6. F | 7. F | 8. T | 9. F | 10. T |
| 11. T | 12. F | 13. T | 14. F | 15. F | 16. F | 17. T | 18. T | 19. T | 20. F |
| 21. T | 22. T | 23. T | 24. F | 25. T | | | | | |

'FILL IN THE BLANKS' TYPE QUESTIONS

- Atoms combine together to acquire stable electronic configurations similar to those of
- The number of dots in a Lewis symbol signifies the number of in the shell of the atom.
- The valency of a phosphide ion is
- When gaseous ions condense together to form a crystal, the energy is This energy is called energy.
- Covalent compounds may exhibit isomerism because covalent bonds are and
- An ethylene molecule contains covalent bonds.
- dipole moment is a quantity.
- CO_2 molecule is regarded as a molecule although it contains polar bonds.
- Ionic bond may be regarded as an case of a covalent bond.
- Polarisation is favoured when cation is and anion is
- Hydrogen bond energy is around kJ mol^{-1} .
- Paramagnetism is shown by the molecules having electrons.
- When N_2 goes to N_2^+ , the N—N bond distance and when O_2 goes to O_2^+ the O—O bond distance (I.I.T., 1996)
- [Hint : Bond orders of N_2 , N_2^+ and O_2^+ are 3, 2.5, 2 and 2.5 respectively. A decrease in bond order increases the bond length whereas an increase in bond order decreases the bond length.]
- Molecular orbitals can best be approximated by the combination of orbitals.
- Electrons present in antibonding molecular orbitals lead to between the combining atoms.
- The bond multiplicity leads to in bond distance.
- A π -molecular orbital is formed by the overlapping of atomic orbitals.
- A molecule is unstable when the bond order is or
- Among N_2^+ , N_2^- and N_2^{2-} , the least stable ion is
- The bond order of O_2^{2-} ion is and the ion is magnetic in nature.

Answers

- | | | | |
|-------------------------------|-----------------------|--------------------|----------------------|
| 1. noble gases | 2. electrons, valence | 3. three | 4. released, lattice |
| 5. stereo, rigid, directional | 6. six | 7. vector | 8. non-polar, two |
| 9. extreme, polar | 10. small, large. | 11. 3.5–4.0 | 12. unpaired |
| 13. increases, decreases | 14. linear, atomic | 16. repulsion | 16. decrease |
| 17. side wise | 18. zero, negative | 19. N_2^- | 20. 1, dia |