KD EDUCATION ACADEMY [9582701166] Street no. 21 A-1 Bengali colony sant nagar burari

Time : 6 Hour

STD 11 Science Chemistry

kd 90+ chemical bonding and molecular structure

Total Marks : 220

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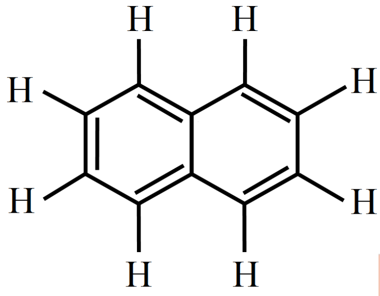
* Choose The Right Answer From The Given Options.[1 Marks Each] [62]

1. Kossel and Lewis approach was based on the:
   - (A) Reactivity of elements.
   - (B) Inertness of noble gases.
   - (C) Reactivity of metals.
   - (D) Inertness of non-metals.

2. Number of π bonds and σ bonds in the following structure is:



Naphthalene

   - (A) 6, 19
   - (B) 4, 20
   - (C) 5, 19
   - (D) 5, 20

3. The decreasing order of the repulsive interaction of electron pairs is (Here, lp = lone pair, bp = bond pair):
   - (A) lp-lp > lp-bp > bp-bp.
   - (B) lp-bp > lp-lp > bp-bp.
   - (C) lp-lp > bp-bp > lp-bp.
   - (D) bp-bp > lp-lp > lp-bp.

4. The product of the magnitude of the charge and the distance between the centres of positive and negative charge is called:
   - (A) Charge ratio.
   - (B) Dipole moment.
   - (C) Current flow.
   - (D) Magnetic moment.

5. In an octahedral structure, the pair of d-orbitals involved in d^2sp^3 hybridisation is:
   - (A) $d_{x^2-y^2}, d_{xz}$
   - (B) d_{z^2}, d_{xy}
   - (C) d_{xy}, d_{y^2}
   - (D) $d_{x^2-y^2}, d_{z^2}$

6. CO is isoelectronic with:
   - (A) NO^+
   - (B) N_2
   - (C) $SnCl_2$
   - (D) NO2

7. The correct order of a dipole moment is:
   - (A) $CH_4<NF_3<NH_3<H_2O$
   - (B) $NF<CH_4<NH_3<H_2O$
   - (C) $NH_3<NF_3<CH_4<H_2O$
   - (D) $H_2O<NH_3<NF_3<CH_4$

8. The charge in coulombs on N^{3-} ion is:
   - (A) 4.80×10^{-19}C
   - (B) 1.60×10^{-19}C
   - (C) -3C
   - (D) 1.8×10^{-24}C

9. The number of lone pairs of electron on Xe in $XeOF_4$ is:
   - (A) 1
   - (B) 2
   - (C) 3
   - (D) 4

10. Which of the following is an electron deficient molecule?

(A) C_2H_6 (B) B_2H_6 (C) SiH_4 (D) PH_3

11. Which is the correct order of decreasing reactivity of metals?

(A) K>Na>Cu>Au
(B) Na>Au>Cu>K
(C) Cu>Na>K>Au
(D) Au>Cu>Na>K

12. The structure which represents the molecular structure more accurately is called:

(A) Resonance hybrid.
(B) Canonical structure.
(C) Resonating structure.
(D) None of these.

13. Which is not characteristic of π - bond?

(A) π - bond is formed when a sigma bond already formed.
(B) π - bond are formed from hybrid orbitals.
(C) π - bond may be formed by the overlapping of p-orbitals.
(D) π - bond results from lateral overlap of atomic orbitals.

14. Valence bond theory of Pauling and Slater accounts for the following characteristic of covalent bond:

(A) Directional
(B) Ionic
(C) Strength
(D) Hybrid

15. Shape of the molecules is decided by:

(A) σ-bond
(B) π-bond
(C) Both σ and π bonds
(D) Neither σ nor π bond

16. How many lone pair of electrons are present on the central atom of CH_4, NH_3, PCl_3 and PCl_5 molecules?

(A) 0, 1, 1, 0 (B) 0, 1, 1, 1 (C) 0, 0, 1, 1 (D) 0, 0, 0, 1

17. Ionic bonds will be formed more easily between elements with comparatively:

(A) Low ionisation enthalpy and high electron affinity.
(B) High ionisation enthalpy and high electron affinity.
(C) Low ionisation enthalpy and low electron affinity.
(D) High ionisation enthalpy and low electron affinity.

18. Which of the following molecules does not have a lone pair of electrons?

(A) HCl (B) CO_2 (C) CH_4 (D) NH_3

19. Which of the following molecule does not show hydrogen bonding?

(A) HF (B) H_2O (C) NH_3 (D) H_2S

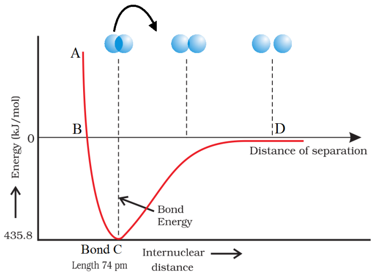
20. A sigma bond is formed by the overlapping of:

(A) s − s orbital alone
(B) s and p orbital alone.
(C) s − s, s − p or p − p orbital along internuclear axis.
(D) p − p orbital along the sides.

21. Which of the following isoelectronic and isostructural:

(A) CO^{2-}, NO_3^{0-}
(B) ClO_3^-, CO_3^{2-}
(C) SO_3^{2-}, NO_3^-
(D) ClO_3^-, SO_3^{2-}

22.



The above potential energy curve is given for the formation of H_2 molecule as a function of internuclear distance of H-atoms. At what point in the curve H, is found in the most stable state?

(A) A (B) B (C) C (D) D

23. The total number of electrons involved in the formation of CH_4 molecule are:

(A) 6 (B) 2 (C) 4 (D) 8

24. The species which has bond angle 120°

(A) $\mathrm{ClF_3}$ (B) $\mathrm{NCl_3}$ (C) $\mathrm{BCl_3}$ (D) $\mathrm{PH_3}$

25. Which of the following molecules has a triple bond?

(A) CH_4 (B) C_2H_4 (C) C_2H_2 (D) O_3

26. The number and types of bonds in calcium carbide and:

(A) $1\sigma, 1\pi$ (B) $2\sigma, 1\pi$ (C) $2\sigma, 2\pi$ (D) $1\sigma, 2\pi$

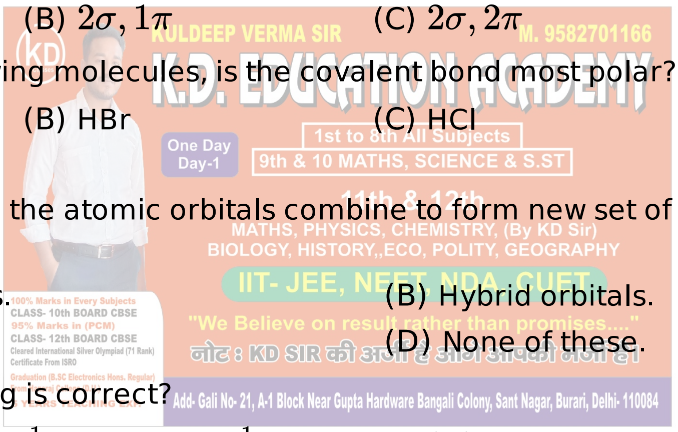
27. In which of the following molecules, is the covalent bond most polar?

(A) HI (B) HBr (C) HCl (D) H_2

28. According to Pauling, the atomic orbitals combine to form new set of equivalent atomic orbitals known as:

(A) Molecular orbitals. (B) Hybrid orbitals.

(C) Pure orbitals. (D) None of these.



29. Which of the following is correct?

(A) Bond order, $\propto \frac{1}{\text{bond length}} \propto \frac{1}{\text{bond enthalpy}} \propto \text{stability}$

(B) Stability, $\propto \frac{1}{\text{bond order}} \propto \frac{1}{\text{bond length}} \propto \frac{1}{\text{bond enthalphy}}$

(C) $\text{Stability} \propto \text{bond order} \propto \text{bond length} \propto \text{bond enthlpy}$

(D) $\text{Stability} \propto \text{bond order} \propto \text{bond enthalpy} \propto \frac{1}{\text{bond lenth}}$

30. The shape of SF_4 molecule is:

(A) Trigonal bi-pyramidal. (B) Square planar.

(C) See-saw. (D) Bent.

31. Sigma bond is more stronger than $\pi-$bond because of:

(A) Large extent of overlapping in $\pi-$bond.

(B) Small extent of overlapping in $\sigma-$bond.

(C) Small extent of overlapping in $\pi-$bond.

(D) Both (a) and (b).

32. Which one of the following molecular geometries (i.e. shapes) is not possible for the sp^3d^2 hybridization?

(A) Capped octahedral (B) Octahedral

(C) Square planar (D) Square pyramidal

33. Hydrogen bond formation takes place between the hydrogen atom and an atom having high__________.

(A) Electronaffinity (B) Electronegativity

(C) Ionization potential (D) Atomic size

34. Which of the following compounds shows the presence of intramolecular H-bond?

(A) H_2O_2 (B) HCN

(C) Cellulose (D) Conc. Acetic acid.

35. Which theory can be best understood by considering the formation of the chlorine molecule, Cl_2?

(A) Lewis theory. (B) Langmuir theory.

(C) Lewis-Langmuir theory. (D) Kossel-Lewis theory.

36. The shape of ClF_3 molecule is:

(A) T-shape. (B) Trigonal planar.

(C) Bent shape. (D) None of these.

37. Which of the following species have the same shape?

(A) CO_2 (B) CCl_4 (C) O_3 (D) $NO^-{}_2$

38. The types of hybrid orbitals of nitrogen in NO_2, NO_3 and NH_4 respectively are expected to be:

(A) sp, sp^3 and sp^2 (B) sp, sp^2 and sp^3

(C) sp^2, sp and sp^3 (D) sp^2, sp^3 and sp^3

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

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

40. N_2 molecule contains ________ σ and ________ π^- bonds.

(A) One, four (B) Three, two (C) One, two (D) None

41. In which of the following compounds, H-bonding is strongest in the liquid phase?

(A) HF (B) CH_4 (C) HI (D) PH_3

42. Which of the following molecules all bonds not equal?

(A) $\mathrm{PCl_5}$ (B) $\mathrm{SF_6}$ (C) $\mathrm{BF_3}$ (D) $\mathrm{AIF_3}$

43. VSEPR theory helps in predicting the shape of:

(A) Ionic molecules. (B) Covalent molecules.

(C) Noble gases. (D) All of these.

44. Decreasing order of stability:

(A) $\mathrm{O_2 > O_2^+ > O_2^{2-} > O_2^-}$

(B) $\mathrm{O_2^- > O_2^{2-} > O_3^+ > O_2}$

(C) $\mathrm{O_2^+ > O_2 > O_2^- > O_2^{2-}}$

(D) $\mathrm{O_2^{2-} > O_2^- > O_2 > O_2^+}$

45. Sidgwick and Powell proposed the VSEPR theory which was further developed and refined by:

(A) Johann Dobereiner. (B) Werner Heisenberg.

(C) Nyholm and Gillespie. (D) Neils Bohr.

46. $H - O - H$ bond angle in water is:

(A) 104.5° (B) 109.5° (C) 105.5° (D) 108.5°

47. In a triple bond, there is sharing of:

(A) 3 electrons (B) 4 electrons

(C) 6 electrons (D) None of these

48. Why do the deviations occur from idealized shape of H_2O and NH_3 molecules?

(A) Same hybridisation. (B) Different hybridisation.

(C) Repulsive effect. (D) None of these.

49. The boiling point of a substance increases with increase in:

(A) Intermolecular hydrogen bonding. (B) Intramolecular hydrogen bonding.

(C) Molecular mass. (D) Both (a) and (c).

50. In the following questions two or more options may be correct:

Which of the following attain the linear structure:

(A) $BeCl_2$ (B) NCO^+ (C) NO_2 (D) CS_2

51. Amongst the following elements, whose electronic configurations are given below, the one having the highest ionization enthalpy is:

(A) $[Ne]3s^2 3p^1$ (B) $[Ne]3s^2 3p^3$

(C) $[Ne]3s^2 3p^2$ (D) $[Ar]3d^{10} 4s^2 4p^3$

52. The number of electron bond pairs involved in the formation of hydrogen cyanide molecule are:

(A) Two (B) Eight (C) Three (D) Four

53. Which of the following molecules represents resonance?

(A) O_3 (B) CO_3^{2-} (C) CO_2 (D) All of these.

54. In which of the following pairs, the two species are isostructural:

(A) BrO_3^- and XeO_3

(B) SF_4 and XeF_4

(C) SO_3^{2-} and NO_3^-

(D) BF_3 and NF_3

55. Canonical forms:

(A) Have real existence. (B) Have no real existence.

(C) Are present in equilibrium. (D) Exist in one form for certain fraction of time and to other in remaining time.

56. Which of the following statements is correct?

(A) In the formation of dioxygen from oxygen atoms 10 molecular orbitals will be formed.

(B) All the molecular orbitals in the dioxygen will be completely filled.

(C) Total number of bonding molecular orbitals will not be same as total number of anti bonding orbitals in dioxygen.

(D) Number of filled bonding orbitals will be same as number of filled anti bonding orbitals.

57. The correct order of dipole moment is:

(A) $CH_4 < NF_3 < NH_3 < H_2O$ (B) $NF_3 < CH_4 < NH_3 < H_2O$

(C) $CH_4 < NH_3 < NF_3 < H_2O$ (D) $< H_2O < NH_3 < NF_3 < CH_4$

58. Lewis postulated that atoms achieve the stable octet when they are linked by:

(A) Ionic bonds. (B) Covalent bonds.
(C) Coordinate bonds. (D) Chemical bonds.

59. Which of the following species has four lone pairs of electrons in its outer shell?

(A) I (B) O^- (C) Cl^- (D) He

60. Diagonal hybridisation is the another name of:

(A) sp^3- hybridization. (B) sp^2- hybridisation.
(C) sp-hybridisation. (D) All of the above.

61. Which of the following molecule has net dipole moment zero?

(A) HF (B) H_2O (C) BF_3 (D) $CHCl_3$

62. Which of the following angle corresponds to sp2 hybridisation?

(A) 90° (B) 120° (C) 180° (D) 109°

* a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option. [2]

63. **Note:** In the following questions a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given below each question.

Assertion (A): Sodium chloride formed by the action of chlorine gas on sodium metal is a stable compound.

Reason (R): This is because sodium and chloride ions acquire octet in sodium chloride formation.

i. A and R both are correct, and R is the correct explanation of A.
ii. A and R both are correct, but R is not the correct explanation of A.
iii. A is true but R is false.
iv. A and R both are false.

64. Direction in the following Questions, the Assertion and Reason have been put forward. Read the statements carefully and choose the correct alternative from the following:

a. Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
b. Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
c. Assertion is true but Reason is false.
d. Both Assertion and Reason are false.

Assertion: Ionic compounds usually have high melting and boiling points.

Reason: A large amount of energy is needed to overcome the strong interionic electrostatic attractive forces.

* Answer The Following Questions In One Sentence.[1 Marks Each] [16]

65. Discuss the shape of the following molecules using the VSEPR model:

$BeCl_2$

66. Write the resonance structures for

NO_2.

67. Discuss the shape of the following molecules using the VSEPR model:

AsF_5

68. Write Lewis dot symbols for atoms of the following elements:
Br.

69. Which hybrid orbitals are used by carbon atoms in the following molecules?
CH_3COOH

70. Out of H_2O and H_2S, which is more polar?

71. Out of σ and $\pi-$bonds, which one is stronger and why?

72. Write electron dot structures of CO and $AlCl_3$.

73. What is the magnetic character of the anion of KO_2?

74. Arrange the given bonds in increasing order of polarity:
$\mathrm{P-H, H-O, N-H, H-F}$

75. Why NF_3 is pyramidal but BF_3 is triangular planar?

76. How many nodal planes are present in $\pi(2\mathrm{px})$ and $\pi^*(2\mathrm{px})$ molecular orbitals?

77. Isostructural species are those which have the same shape and hybridisation. Among the given species identify the isostructural pairs.
$\mathrm{NH_3,\ BF_3,\ BF_4^-,\ NH_4^+,\ BCl_3,\ BrCl_3,\ NH_3,\ NO_3^-}$

78. Explain why PCl_5 is trigonal bipyramidal whereas IF_5 is square pyramidal.

79. NH_3 and $\mathrm{NH_4^+}$ have what covalencies?

80. Which of the following does not show resonance and why?
$\mathrm{CO_3^{2-}, BO_3^-, SO_4^{2-}}$

* **Given Section consists of questions of 2 marks each.** **[48]**

81. Write Lewis symbols for the following atoms and ions:
Al and Al^{3+}

82. All the $\mathrm{C-O}$ bonds in carbonate ion $\left(\mathrm{CO_3^{2-}}\right)$ are equal in length. Explain.

83. Why does formic acid exist as dimer? What is its one consequence?

84. Why are dipole moments of $\mathrm{CO_2, BF_3, CCl_4, PF_5, SF_6}$ are zero?

85. Account for the following:
    i. BF, molecule has a zero dipole moment although $\mathrm{B-F}$ bonds are polar.
    ii. The structure of NH_3 molecule is pyramidal.

86. i. KHF, exists but $KHCl_2$, $KHBr_2$ do not, why?
    ii. Out HF, H_2O, HCl, CCl_4 which is not liquid and why?

87. Bond angle in NH_3 is more than in H_2O. Justify.

88. What is the total number of electrons in $\mathrm{NO_3^-}$?

89. What is hybrid state of central atom in the following?
$\mathrm{NO_3^-, BF_4^-, PF_5, IF_5}$ and $\mathrm{CO_2}$

90. What is the state of hybridisation of carbon in $\mathrm{CO_3^{2-}}$ ion?

91. Write resonating structures of O_3.

92. Arrange the following in order of decreasing bond angles.

i. $CH_4, NH_3, H_2O, BF_3, C_2H_2$

ii. NH_3, NH_2, NH_4^+

93. Give correct reason for the following:

i. BF_3 has a zero dipole moment although the $B-F$ bonds are polar.

ii. All carbon to oxygen bonds in CO_3^{2-} are equivalent.

94. Explain why HF is less viscous than H_2O.

95. On the basis of VSEPR theory, predict the shapes of the following molecules and ions:

i. PH_3

ii. NH_3

iii. NH_2^-

iv. H_3O^+

96. Give shapes of:

a. NH_4^+,

b. CO_3^{2-},

c. BeF_3^-,

d. SO_4^{2-}

97. Why is $BeCl_2$ linear whereas $SnCl_2$ angular molecule?

98. Draw the shape of:

i. $XeOF_5$

ii. XeO_3

99. Aluminium forms the ion Al^{3+}, but not Al^{4+} why?

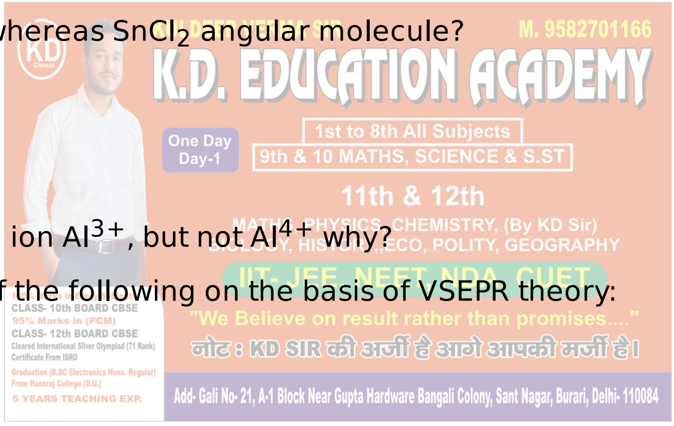
100. Explain the shapes of the following on the basis of VSEPR theory:

a. $BeCl_2$

b. PH_4^+

c. PF_5

d. SF_6



101. i. Which of the following are isostructural species. Give their structures.

$NO_2^+, BCl_3, CO_2, BeCl_2$

ii. Which has most electronegativity of carbon? Why?

$CH_3-CH_3, CH=CH_2, HC\equiv CH$

102. N_2 molecule has a greater bond dissociation energy than N_2^+ ion whereas O_2 molecule has a lower bond dissociation energy than O_2^+ ion. Explain in terms of molecular orbital theory.

103. AlF_3 is a high melting solid whereas SiF_4 is a gas. Explain.

104. Define hybridisation. Explain the structure of C_2H_2 with orbital diagram.

*** Given Section consists of questions of 3 marks each. [39]**

105. Use molecular orbital theory to explain why the Be_2 molecule does not exist.

106. i. Explain, why Be_2 molecule does not exist by using molecular orbital theory.

ii. Describe the state of hybridization in PCl_5 Why are the axial bonds longer as compared to equatorial bonds?

107. Give the shapes of following covalent molecules using VSEPR theory:
   i. ClF_3
   ii. XeF_4
   iii. AsF_5

108. What is meant by hydrogen bond? What is bond energy of hydrogen bond? Why is HF, H_2O are liquids whereas HCl, HBr, HI and H_2S are gases?

109. BeF_2 molecule is linear while SF_2 is angular through both are triatomic?

110. Which of the compounds in pair of compounds has higher dipole moment?
   i. BCl_3 and BF_3
   ii. SO_2 and SO_3
   iii. H_2O and H_2S

111. Draw the shape of the following hybrid orbitals sp, sp^2 and sp^3.

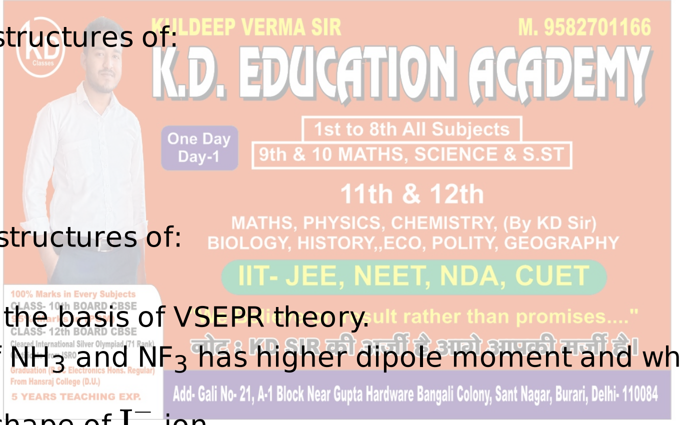
112. Indicate the number of σ and π bonds in the molecule $\mathrm{CH_2 = C = CH_2}$.

113. i. NH_3 has more dipole moment than NF_3 although $\mathrm{N - F}$ bond is more polar than $\mathrm{N - H}$ bond, why?
   ii. H_2O is liquid while H_2S is gas, why?

114. Draw the molecular structures of:
   i. $\mathrm{XeF_2}$,
   ii. $\mathrm{XeOF_2}$
   iii. $\mathrm{XeOF_4}$

115. i. Deduce the structures of:
      a. BrF_5
      b. PF_5 on the basis of VSEPR theory.
   ii. Which out of NH_3 and NF_3 has higher dipole moment and why?

116. i. Explain the shape of $\mathrm{I_3^-}$ ion.
   ii. Why is KO_2 paramagnetic?



117. i. What is the state of hybridisation of nitrogen in $\mathrm{NH_4^+}$ ion?
   ii. Draw the shape of PH_3 and SF_6 according to VSEPR theory.
   iii. Which hybrid orbitals are used by carbon atoms in $\mathrm{CH_3 - CHO}$?

* Case study based questions [8]

118. Read the passage given below and answer the following questions from (i) to (v).
When covalent bond is formed betweentwo similar atoms, for example in H_2,O_2, Cl_2,N_2Or F_2, the shared pair of electrons is equally Attracted by the two atoms. As a result electronPair is situated exactly between the twoIdentical nuclei. The bond so formed is calledNonpolar covalent bond. As a result of polarisation, the moleculePossesses the dipole moment which can be defined as the productOf the magnitude of the charge and theDistance between the centres of positive andNegative charge. It is usually designated by aGreek letter 'μ'. Mathematically, it is expressedAs follows :Dipole moment (μ) = charge (Q) × distance ofSeparationDipole moment is usually expressed inDebye units (D). The conversion factor is1 D = 3.33564×10^{-30} C mWhere C is coulomb and m is meter. Just as all the covalent bonds haveSome partial

ionic character, the ionicBonds also have partial covalentCharacter. The partial covalent character of ionic bonds was discussed by Fajans in terms of the following rules:

- The smaller the size of the cation and theLarger the size of the anion, the greater theCovalent character of an ionic bond.
- The greater the charge on the cation, theGreater the covalent character of the ionic bond.
- For cations of the same size and charge,The one, with electronic configuration(n-1)d^0ns^0, typical of transition metals, isMore polarising than the one with a nobleGas configuration, ns2 np6, typical of alkali and alkaline earth metal cations.

Sidgwick and Powell in 1940, proposed a simple theoryBased on the repulsive interactions of theElectron pairs in the valence shell of the atoms.It was further developed and redefined byNyholm and Gillespie (1957).The main postulates of VSEPR theory areAs follows:

- The shape of a molecule depends uponThe number of valence shell electron pairs(bonded or nonbonded) around the centralAtom.
- Pairs of electrons in the valence shell repelone another since their electron clouds arenegatively charged.
- These pairs of electrons tend to occupySuch positions in space that minimiseRepulsion and thus maximise distanceBetween them.
- The valence shell is taken as a sphere withThe electron pairs localising on theSpherical surface at maximum distanceFrom one another.
- A multiple bond is treated as if it is a singleElectron pair and the two or three electronPairs of a multiple bond are treated as aSingle super pair.
- Where two or more resonance structuresCan represent a molecule, the VSEPRModel is applicable to any such structure.

The arrangement of electron pairs and the atoms around the central atom can be : linear,Trigonal planar, tetrahedral, trigonal-Bipyramidal and octahedral. Valence bond theory was introduced byHeitler and London (1927) and developedFurther by Pauling and others. A discussionOf the valence bond theory is based on the knowledge of atomic orbitals, electronicConfigurations of elements.partialmerging of atomic orbitals is called overlappingof atomic orbitals which results in the pairingof electrons. The extent of overlap decides thestrength of a covalent bond. according toorbital overlap concept, the formation of acovalent bond between two atoms results bypairing of electrons present in the valence shellhaving opposite spins. When orbitals of two atoms come close to formbond, their overlap may be positive, negativeor zero depending upon the sign anddirection of orientation of amplitude of orbitalwave function in space. Positive andnegative sign on boundary surface diagramsin the show the sign (phase) of orbitalwave function and are not related to charge.Orbitals forming bond should have same sign(phase) and orientation in space. This is calledpositive overlap. The criterion of overlap, as the main factorfor the formation of covalent bonds appliesuniformly to the homonuclear/heteronucleardiatomic molecules and polyatomic molecules.

i. Dipole moment is usually expressed in....
   a. Debye
   b. Centimeter

c. Columbs

d. Ergs

ii. 1D = ...

a. 33564×10^{-28}Cm

b. 3.3564×10^{-30}Cm

c. 33564×10^{-32}Cm

d. 33564×10^{-34}Cm

iii. Valence bond theory was introduced by ....

a. Pauling and lewis

b. Nyholm and Gillespie

c. Heitler and London

d. Sidgwick and Powell

iv. Pair is situated exactly between the two Identical nuclei the bond so formed is called .... covalent bond.

a. Unipolar

b. Bipolar

c. Polar

d. Nonpolar

v. Pairs of electrons in the valence shell ... one another since their electron clouds are negatively charged.

a. Attract

b. Repel

c. Both a) & b)

d. None if above

119. Read the passage given below and answer the following questions from (i) to (v).

The covalent bond may be classified into twotypes depending upon the types ofoverlapping:(i) Sigma(σ) bond, and (ii) pi(π) bond

1. Sigma(σ) bond: This type of covalent bondis formed by the end to end (head-on)overlap of bonding orbitals along theinternuclear axis. This is called as headon overlap or axial overlap. This can beformed by any one of the following typesof combinations of atomic orbitals.

s-s overlapping: In this case, there isoverlap of two half filled s-orbitals alongthe internuclear axis.

s-p overlapping: This type of overlapoccurs between half filled s-orbitals of oneatom and half filled p-orbitals of anotheratom.

p–p overlapping: This type of overlaptakes place between half filled p-orbitalsof the two approaching atoms.

2. pi(π) bond: In the formation of π bondthe atomic orbitals overlap in such a waythat their axes remain parallel to each otherand perpendicular to the internuclear axis.The orbitals formed due to sidewiseoverlapping consists of two saucer type charged clouds above and below the planeof the participating atoms.

Basically the strength of a bond depends uponthe extent of overlapping. In case of sigma bond,the overlapping of orbitals takes place to alarger extent. Hence, it is stronger as comparedto the pi bond where the extent of overlappingoccurs to a smaller extent. Further, it isimportant to note that in the formation ofmultiple bonds between two atoms of amolecule, pi bond(s) is formed in addition to asigma bond. In order to explain the characteristicgeometrical shapes of polyatomic moleculeslike CH_4,NH_3 and H_2O etc., Pauling introducedthe concept of hybridisation. According to himthe atomic orbitals combine to form new set ofequivalent orbitals known as hybrid orbitals.Unlike pure orbitals, the hybrid orbitals areused in bond formation. The phenomenon isknown as hybridisation which can be definedas the process of intermixing of the orbitals ofslightly different energies so as to redistributetheir energies, resulting in the formation of newset of orbitals of equivalent energies and shape.For example when one 2s and three 2p-orbitalsof carbon hybridise, there is the formation offour new sp^3 hybrid orbitals. Salient features of hybridisation: The mainfeatures of hybridisation are as under:

1. The number of hybrid orbitals is equal tothe number of the atomic orbitals that gethybridised.
2. The hybridised orbitals are alwaysequivalent in energy and shape.
3. The hybrid orbitals are more effective informing stable bonds than the pure atomicorbitals.
4. These hybrid orbitals are directed in spacein some preferred direction to haveminimum repulsion between electronpairs and thus a stable arrangement.Therefore, the type of hybridisationindicates the geometry of the molecules. Important conditions for hybridisation
5. The orbitals present in the valence shell of the atom are hybridised.
6. The orbitals undergoing hybridisation should have almost equal energy.
7. Promotion of electron is not essential condition prior to hybridisation.
8. It is not necessary that only half filled orbitals participate in hybridisation.

some cases, even filled orbitals of valence shell take part in hybridisation.

There are various types of hybridisationinvolving s, p and d orbitals. The differenttypes of hybridisation are as under:

1. sp hybridisation: This type ofhybridisation involves the mixing of one s andone p orbital resulting in the formation of twoequivalent sp hybrid orbitals. The suitableorbitals for sp hybridisation are s and pz, ifthe hybrid orbitals are to lie along the z-axis. Example of molecule having sphybridisation$BeCl_2$: The ground state electronicconfiguration of Be is $1s^2 2s^2$. In the exited stateone of the 2s-electrons is promoted to vacant 2p orbital to account for its bivalency.One 2s and one 2p-orbital gets hybridised toform two sp hybridised orbitals.
2. sp2 hybridisation : In this hybridisationthere is involvement of one s and twop-orbitals in order to form three equivalent sp2hybridised orbitals. For example, in BCl3molecule, the ground state electronicconfiguration of central boron atom is$1s^2 2s^2 2p^1$. In the excited state, one of the 2selectrons is promoted to vacant 2p orbital as a result boron has three unpaired electrons.These three orbitals (one 2s and two 2p)hybridise to form three sp2 hybrid orbitals.
3. sp^3 hybridisation: This type ofhybridisation can be explained by taking theexample of CH_4 molecule in which there ismixing of one s-orbital and three p-orbitals ofthe valence shell to form four sp^3 hybrid orbitalof equivalent energies and shape. There is 25%s-character and 75% p-character in each sp^3hybrid orbital. The four sp^3 hybrid orbitals soformed are directed towards the four cornersof the tetrahedron. The angle between sp^3hybrid orbital is 109.5°.

i. ....ntroduced the concept of hybridisation.
   a. Pauling
   b. Lewis
   c. Nyholm
   d. Gillespie
ii. Which of the following is an example of sp3 hybridization?
   a. BeCl2

b. Ch4
c. BCl3
d. C2H4

iii. The angle between sp3 hybrid orbital is ….
a. 5°
b. 9°
c. 109.5°
d. 120°

iv. A sigma bond is formed by the overlapping of …
a. s−s,
b. s−p
c. p−p
d. All the above

v. When one 2s and three 2p-orbitals of carbon hybridise, there is the formation of four new … hybrid orbitals.
a. sp3
b. sp2
c. sp
d. None of above

*** Given Section consists of questions of 5 marks each. [45]**

120. Which out of NH_3 and NF_3 has higher dipole moment and why?

121. Although both CO_2 and H_2O are triatomic molecules, the shape of H_2O molecule is bent while that of CO_2 is linear. Explain this on the basis of dipole moment.

122. Explain the formation of H_2 molecule on the basis of valence bond theory.

123. Define octet rule. Write its significance and limitations.

124. Write the favourable factors for the formation of ionic bond.

125. Define hydrogen bond. Is it weaker or stronger than the van der Waals forces?

126. Give reasons for the following:
a. Covalent bonds are directional bonds while ionic bonds are non- directional.
b. Water molecule has bent structure whereas carbon dioxide molecule is linear.
c. Ethyne molecule is linear.

127. i. Why is HF liquid but HCl, HBr, HI are gases?
ii. Why is o-nitrophenol steam volatile whereas p-nitrophenol is not steam volatile?
a. Arrange the following in decreasing order of their bond angle: H_2O, NH_3, H_2S
b. Sketch the bond moments and resultant dipole moment of the following molecule:
H_2O, NH_3, NF_3 and PCl_5
c. Draw shape of the following molecules on the basis of VSEPR theory:
XeF_4 and SF_4. (At. No. of Xe = 54, At. No. of S = 16)

128. Arrange in properties:
i. HF, HCl, HBr, HI [Thermal stability]
ii. LiF, LiCl, LiBr, LiI [Ionic character]
iii. PH_3, PCl_3, PF_3, [Covalent character]
iv. H_2O, NH_3, H_2S, HF [Polarity]
v. $BeCl_2$, BCl_3, CCl_4, PCl_3, [Bond angle]

----- Do the best you can until you know better. Then when you know better, do better. -----