Exercise # 2

SINGLE OBJECTIVE

AIIMS LEVEL

1. Pick out among the following species isoelectronic with CO_2.

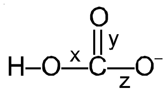
(A) N_3^-
(B) $(CNO)^-$
(C) $(NCN)^{2-}$
(D) All of these

2. The correct order of increasing C-O bond length of CO, CO_3^{2-}, CO_2 is :

(A) $CO_3^{2-} < CO_2 < CO$
(B) $CO_2 < CO_3^{2-} < CO$
(C) $CO < CO_3^{2-} < CO_2$
(D) $CO < CO_2 < CO_3^{2-}$

3. The average charge on each O atom and average bond order of I–O bond in IO_6^{5-} is :

(A) –1 and 1.67
(B) – 5/6 and 1.67
(C) –5/6 and 1.33
(D) –5/6 and 1.167

4. 
$\mathrm{H{-}O\overset{x}{—}\overset{\overset{O}{\|\,y}}{C}\underset{z}{—}O^{-}}$ The relation between x, y and z in bicarbonate ion with respect to bond length is :

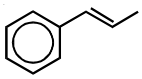
(A) x > y > z
(B) x > z > y
(C) z = y > x
(D) x > y = z

5. Indicate the wrong statement :

(A) A sigma bond is stronger then π - bond
(B) p-orbitals always have only sidewise overlapping
(C) s-orbitals never form π - bonds
(D) There can be only one sigma bond between two atoms

6. C_3^{4-} has

(A) two σ and two π bond
(B) three σ and one π bond
(C) two σ and one π bond
(D) two σ and three π bond

7. How many bonds are there in  ?

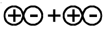
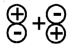
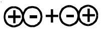
(A) 13
(B) 23
(C) 20
(D) 26

8. Which of the following overlaps is **incorrect** [assuming z-axis to be the internuclear axis] ?

(A) $2\,p_y + 2\,p_y \rightarrow \pi\,2\,p_y$
(B) $2\,p_z + 2\,p_z \rightarrow \sigma\,2p_z$
(C) $2\,p_x + 2\,p_x \rightarrow \pi\,2\,p_x$
(D) $1\,s + 2\,p_y \rightarrow \pi\,(1\,s\text{-}2\,p_y)$

(A) ‘a’ & ‘b’
(B) ‘b’ & ‘d’
(C) only ‘d’
(D) None of these

9. Effective overlapping will be shown by :

(A) 
(B) 
(C) 
(D) All the above

10. The covalency of nitrogen in HNO_3 is

(A) 0
(B) 3
(C) 4
(D) 5

11. What is covalency of I in IF_7 ?

(A) 5
(B) 3
(C) 7
(D) 1

12. In which of the following N is in the sp^2 hybridisation state

(A) $(CH_3)_3N$
(B) CH_3CONH_2
(C) CH_3CN
(D) NO_2^+

13. In pent-3-en-1-yne the terminal carbon-atoms have following hybridisation

(A) sp & sp^2
(B) sp^2 & sp^3
(C) sp^2 & sp
(D) sp & sp^3

14. Identify the correct match.

(i) XeF_2
(A) Central atom has sp^3 hybridisation and bent geometry.

(ii) N_3^-
(B) Central atom has sp^3d^2 hybridisation and octahedral.

(iii) PCl_6^-(PCl_5 (s) anion)
(C) Central atom has sp hybridisation and linear geometry.

(iv) ICl_2^+ (I_2Cl_6 (ℓ) cation)
(D) Central atom has sp^3d hybridisation and linear geometry.

(A) (i – a), (ii – b), (iii – c), (iv – d)
(B) (i – d), (ii – b), (iii – d), (iv – c)
(C) (i – b), (ii – c), (iii – a), (iv – d)
(D) (i – d), (ii – c), (iii – b), (iv – a)

15. Which of the following statement is true for $IO_2F_2^-$?

(A) The electrons are located at the corners of a trigonal bipyramidal but one of the equatorial pairs is unshared.

(B) It has sp^3d hybridisation and is T–shaped.

(C) Its structure is analogous to SF_4.

(D) **(A)** and **(C)** both

16. Consider the following molecules ;

H_2O	H_2S	H_2Se	H_2Te
I	II	III	IV

Arrange these molecules in increasing order of bond angles.

(A) I < II < III < IV
(B) IV < III < II < I
(C) I < II < IV < III
(D) II < IV < III < I

17. In which of the following bond angle is maximum

(A) NH_3
(B) NH_4^+
(C) PCl_3
(D) $SnCl_2$

18. Consider the following statement and arrange in the order of true / false.

S_1 : In $SnCl_2$ the bonding takes place in ground state and the bond angle Cl–Sn–Cl is slightly less than 120º.

S_2 : The molecular geometry of XeF_7^+ is pentagonal bipyramidal having two different Xe–F bond lengths.

S_3 : In SF_4 , the bond angles, instead of being 90º and 180º are 89º and 177º respectively due to the presence of a lone pair.

(A) T T T
(B) F T T
(C) T T F
(D) T F T

19. Consider the following statements

1. Steric number '7' gives 'sp^3d^3 hybridisation.

2. In $C\ell F_3$ at least one bond angle is exactly 180°

3. Lone pair does not cause any distortion in the bond angle.

The above statements 1, 2, 3 respectively are

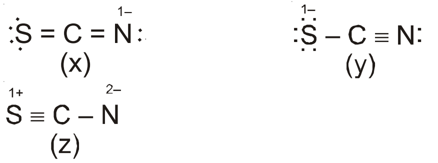
(T = True, F = False)

(A) T F F
(B) T T F
(C) F T F
(D) T T T

20. Which one has highest bond angle.

(A) NH_3
(B) PH_3
(C) H_2O
(D) CH_4

21. In the thiocyanate ion, SCN^- three resonating structure are possible with the electron-dot method as shown in figure



The decreasing order of % contribution in resonance hybrid is :

(A) y > x > z
(B) y > z > x
(C) z > x > y
(D) cannot predicted.

22. The correct order of C–N bond length in the given compounds is :

P : CH_3CN
Q : HNCO
R : CH_3CONH_2

(A) P > Q > R
(B) P = Q = R
(C) R > Q > P
(D) R > P > Q

23. Which of the following statements is not correct for sigma and pi bond formed between two carbon atoms?

(A) Free rotation of atoms about a sigma - bond is allowed but not in case of a pi-bond

(B) Sigma -bond determines the direction between carbon atoms but a pi-bond has no primary effect in this regard

(C) Sigma-bond is stronger than a pi-bond

(D) Bond energies of sigma- and pi-bonds are of the order of 264 kJ/mol and 347 kJ/mol. respectively.

24. Number and type of bonds between two carbon atoms in CaC_2 are :

(A) one sigma (σ) and one pi (π) bond
(B) one σ and two π bonds
(C) one σ and one and a half π bond
(D) one σ bond

25. The number of σ and π bonds in dicyanogen $(CN)_2$ are :

(A) $2\sigma + 3\pi$
(B) $3\sigma + 2\pi$
(C) $3\sigma + 4\pi$
(D) $4\sigma + 3\pi$

26. Indicate the incorrect statement :

(A) An 'sp' hybrid orbital is not lower in energy than both s- and p-orbitals

(B) $2p_x$ and $2p_y$ - orbitals of carbon can be hybridized to yield two new more stable orbitals

(C) Effective hybridisation is not possible with orbitals of widely different energies

(D) The concept of hybridisation has a greater significance in the VB theory of localised orbitals than in the MO theory.

27. The correct order of increasing s character (in percentage) in the hybrid orbitals in below molecules / ions is (assume all hybrid orbitals are exactly equivalent) :

CO_3^{2-} XeF_4 I_3^-
NCl_3 $BeCl_2$ (g)

I II III
IV V

(A) II < III < IV < I < V

(B) II < IV < III < V < I

(C) III < II < I < V < IV

(D) II < IV < III < I < V

28. Which of the following contains both electrovalent and covalent bonds ?

(A) CH_4 **(B)** H_2O_2
(C) NH_4Cl **(D)** none

29. In the following which substance will have highest boiling point

(A) He **(B)** CsF
(C) NH_3 **(D)** $CHCl_3$

30. Arrange the following in order of decreasing N – O bond length : NO_2^+ , NO_2^- , NO_3^-

(A) $NO_3^- > NO_2^+ > NO_2^-$
(B) $NO_3^- > NO_2^- > NO_2^+$

(C) $NO_2^+ > NO_3^- > NO_2^-$
(D) $NO_2^- > NO_3^- > NO_2^+$

31. sp^3d hybridization is considered to be a combination of two hybridization. They are

(A) $p^3 + sd$

(B) $sp^2 + pd$

(C) $spd + p^2$

(D) none of these

32. Which of the following should have pyramidal shape :

(A) $[ClOF_2]^+$

(B) ICl_3

(C) $[BrICl]^-$

(D) All of these

33. The maximum Covalency for representative elements is equal to (excluding 1st and 2nd period)
(A) the number of unpaired p-electrons
(B) the number of paired d-electrons
(C) the number of unpaired s and p-electrons
(D) the actual number of s and p-electrons in the outermost shell.

34. Which of the following are not characteristics of metallic solids ?
(A) high electrical conductivity
(B) malleable and ductile
(C) the free electrons give them lustrous appearance

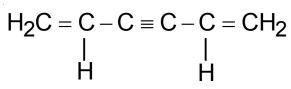
(D) electrical conductivity increases on increasing temperature

35. Two element have electronegativity of 1.2 and 3.0. Bond formed between them would be :
(A) more ionic **(B)** polar Covalent
(C) co-ordinate **(D)** metallic

36. Which of the following overlaps gives a σ bond with x as internuclear axis?
(A) p_z and p_z **(B)** s and p_z
(C) s and p_x **(D)** $d_{x^2-y^2}$ and $d_{x^2-y^2}$

37. Which of the statements is correct about SO_2 ?
(A) two σ, two π and no lone pair of electrons
(B) two σ and one π
(C) two σ, two π and one lone pair
(D) none of these

38. Which of the following is **true** statement ?

(A) All the carbon in  $H_2C=\underset{\displaystyle H}{\underset{|}{C}}-C\equiv C-\underset{\displaystyle H}{\underset{|}{C}}=CH_2$ are in sp^2 hybridisation.
(B) In $C_2H_2(CN)_2$ there are six 'σ' bonds.
(C) In C_2H_6, all C are sp^2 hybridized
(D) In C_3O_2 all the carbons are in sp hybridisation.

39. Correct order of bond energy of C–O bond is :
(A) $CO_3^{2-} > CO_2 > CO$ **(B)** $CO_2 > CO > CO_3^{2-}$
(C) $CO > CO_2 > CO_3^{2-}$ **(D)** None of these.

40. For hydrazoic acid , which of the following resonating structure will be least stable ?

$$\underset{(I)}{H-N=N^{+}=N^{-}} \longleftrightarrow \underset{(II)}{H-N^{+}-N^{+}=N^{2-}} \longleftrightarrow \underset{(III)}{H-N^{-}-N^{+}\,{}^{o}\,N}$$

(A) I **(B)** I I
(C) I I F **(D)** Both (I) and (III)

41. The correct order of increasing s character (in percentage) in the hybrid orbitals in below molecules / ions is (assume all hybrid orbitals are exactly equivalent) :

$SnCl_2$	XeF_4	I_3^-
NCl_3	$HgCl_2$ (g)	
I	II	III
IV	V	

(A) II < III < IV < I < V
(B) II < IV < III < V < I
(C) III < II < I < V < IV
(D) II < IV < III < I < V

42. The hybrid state of positively charged carbon in vinyl cation ($CH_2 = \overset{\oplus}{C}H$) is :

(A) Unpredicatable **(B)** sp^2
(C) sp **(D)** sp^3

43. If the equatorial plane is x– y plane in sp^3d hybridisation then the orbital used in pd hybridisation are -

(A) p_z and d_{z^2} **(B)** p_x and d_{xy}
(C) p_y and d_{yz} **(D)** none of these

44. Incorrect order about bond angle is :

(A) $H_2O > H_2S > H_2Se > H_2Te$
(B) $C_2H_2 > C_2H_4 > CH_4 > NH_3$
(C) $SF_6 < NH_3 < H_2O < OF_2$
(D) $ClO_2 > H_2O > H_2S > SF_6$

45. In the structure of H_2CSF_4, to decide the plane in which C = S is present the following bond angle values are given

Axial FSF angle (idealised = 180°) ⇒ 170°
Equatorial FSF angle (idealised = 120°) ⇒ 97°

After deciding the plane of double bond, which of the following statement is/are correct ?

(A) two C – H bonds are in the same plane of axial S – F bonds
(B) two C – H bonds are in the same plane of equatorial S – F bonds
(C) total five atoms are in the same plane
(D) equatorial S – F bonds are perpendicular to plane of π-bond

46. The bond length in LiF will be

(A) less than that of NaF
(B) equal to that of KF
(C) more than that of KF
(D) equal to that of NaF

47. **S1 :** Oxidation number of N in N_2O_5 is 5
S2 : The anhydride of Hypochlorous acid is Cl_2O
S3 : As the electronegativity of central atom in a molecule having same hybridisation state and same terminal atoms increases, bond angle increases.
S4 : For heteronuclear diatomic species A – B, the bond length decreases as the difference in electronegativity values increases.

(A) T T T F **(B)** F T T T
(C) F F T F **(D)** T T F T

48. In the cation $[H–C–N–Xe–F]^+$ which is linear, the hybridisations of C, N & Xe atoms respectively are

(A) sp, sp, sp **(B)** sp , sp^2, sp^3d
(C) sp, sp, sp^3d **(D)** sp^2 , sp, sp^3d

49. The structure of $IO_2F_2^-$ is analogous to :

(A) SF_4 **(B)** XeO_2F_2
(C) F_2SeO_2 **(D)** **(A)** and **(B)** both

50. Which of the following about SF_4, SOF_4 and OCF_2 molecules is correct.

(A) Equitorial FSF bond angle in SOF_4 will be greater than in SF_4 molecule
(B) Hybridisation states of sulphur in SF_4 and SOF_4 molecules will be different.
(C) The bond angle FCO will be < 120° in molecule OCF_2
(D) The axial FSF bond angle in SF_4 is exactly 180°

51. Which of the following molecules has two lone pairs and bond angle (need not be all bond angles) < 109.5°?

(A) SF_2 **(B)** KrF_4
(C) ICl_4^- **(D)** All of these

52. For B_2H_6

S1 : Each boron is sp^3 hybridised
S2 : from terminal 'H' & two 'B' atom are in same plane but two bridge hydrogen in different plane.
S3 : It has 4 σ bond & 2 bridge bond
S4 : 8 σ bonds are present in it

(A) T T F F **(B)** T T T F
(C) F F T F **(D)** F T F T

53. Which combination is best explained by the co-ordinate covalent bond

(A) $H^+ + H_2O$ **(B)** $Cl + Cl$
(C) $Mg + \frac{1}{2}O_2$ **(D)** $H_2 + I_2$

54. Which of the following contains a coordinate covalent bond

(A) HNO_3
(B) $BaCl_2$
(C) HCl
(D) H_2O

55. Bonds present in $CuSO_4 . 5H_2O(s)$ is

(A) Electrovalent and covalent
(B) Electrovalent and coordinate
(C) Electrovalent, covalent and coordinate
(D) Covalent and coordinate

56. Identify the species containing Banana bonds

(A) $(BeH_2)_n$
(B) BF_3
(C) $(AlCl_3)_2$
(D) $(BeCl_2)_n$

57. Which is not true about B_2H_6

(A) Both 'B' atoms are sp^3 hybridised
(B) Boron atom is in ground state
(C) Two hydrogens occupy special positions
(D) There are two, three centre two electron bonds

58. Which of the following compounds has coordinate (dative) bond

(A) CH_3NC
(B) CH_3OH
(C) CH_3Cl
(D) NH_3

59. Which of the following statements regarding the structure of $SOCl_2$ is not correct ?

(A) The sulphur is sp^3 hybridised and it has a tetrahedral shape.
(B) The sulphur is sp^3 hybridised and it has a trigonal pyramid shape.
(C) The oxygen -sulphur bond is $p\pi$ - $d\pi$ bond.
(D) It contain one lone pair of electrons in the sp^3 hybrid orbital of sulphur.

60. For BF_3 molecule which of the following is true ?

(A) B-atom is sp^2 hybridised.
(B) There is a $P\pi - P\pi$ back bonding in this molecule.
(C) Observed B–F bond length is found to be less than the expected bond length.
(D) All of these

61. For BF_3 molecule which of the following will not be true

(A) It has less bond length than BF_4^-
(B) It has less bond length than the compound $[NH_3 \rightarrow BF_3]$
(C) It's bond strength is increased because of $p\pi$–$d\pi$ back bonding
(D) It forms BF_4^- when hydrolysed in water.

62. Respective order of strength of back-bonding and Lewis acidic strength in boron trihalides is :

(A) $BF_3 < BCl_3 < BBr_3$ and $BF_3 < BCl_3 < BBr_3$
(B) $BF_3 > BCl_3 > BBr_3$ and $BF_3 > BCl_3 > BBr_3$
(C) $BF_3 > BCl_3 > BBr_3$ and $BF_3 < BCl_3 < BBr_3$
(D) $BF_3 < BCl_3 < BBr_3$ and $BF_3 > BCl_3 > BBr_3$

63. If Z-axis is the molecular axis, then π-molecular orbitals are formed by the overlap of

(A) $s + p_z$
(B) $p_x + p_y$
(C) $p_z + p_z$
(D) $p_x + p_x$

64. The common features of the species N_2^{2-}, O_2 and NO^- are :

(A) bond order three and isoelectronic.
(B) bond order two and isoelectronic.
(C) bond order three but not isoelectronic.
(D) bond order two but not isoelectronic.

65. Which of the following molecular orbitals has two nodal planes

(A) $\sigma 2s$
(B) $\pi 2p_y$
(C) $\pi^* 2p_y$
(D) $\sigma^* 2p_x$

66. During the formation of a molecular orbital from atomic orbitals of the same atom, probability of electron density is

(A) none zero in the nodal plane
(B) maximum in the nodal plane
(C) zero in the nodal plane
(D) zero on the surface of the lobe

67. Bond order is a concept in the molecular orbital theory. It depends on the number of electrons in the bonding and antibonding orbitals. Which of the following statements is true about it ? The bond order

(A) Can have a negative quantity
(B) Has always an integral value
(C) Can assume any positive or integral or fractional value including zero
(D) Is a non zero quantity

68. Which of the following pairs have identical values of bond order ?

(A) N_2^+ and O_2^+
(B) F_2 and Ne_2
(C) O_2 and B_2
(D) C_2 and N_2

69. Which of the following molecules /ions exhibit sp mixing?

(A) B_2
(B) C_2^{2-}
(C) O_2^+
(D) Both **(A)** and **(B)**

70. Among the following species, which has the minimum bond length ?

(A) B_2 **(B)** C_2
(C) F_2 **(D)** O_2^-

71. Which of the following species is paramagnetic ?

(A) NO^- **(B)** O_2^{2-}
(C) CN^- **(D)** CO

72. The following molecules / species have been arranged in the order of their increasing bond orders, Identify the correct order.

(I) O_2 ; (II) O_2^- ; (III) O_2^{2-} ; (IV) O_2^+

(A) III < II < I < IV **(B)** IV < III < II < I
(C) III < II < IV < I **(D)** II < III < I < IV

73. Which of the following statements is incorrect ?

(A) Among O_2^+, O_2 and O_2^- the stability decreases as $O_2^+ > O_2 > O_2^-$

(B) He_2 molecule does not exist as the effect of bonding and anti-bonding orbitals cancel each other .

(C) C_2 ,O_2^{2-} and Li_2 are diamagnetic

(D) In F_2 molecule, the energy of σ_{2p_z} is more than π_{2p_x} and π_{2p_y}

74. Which one is paramagnetic from the following

(A) O_2^- **(B)** NO
(C) Both **(A)** and **(B)** **(D)** CN^-

75. Which of the following orders is correct in respect of bond dissociation energy ?

(A) $N_2^+ > N_2^-$ **(B)** $O_2^+ > O_3$
(C) $NO^+ > NO$ **(D)** All of those

76. Which of the following statement is incorrect ?

(A) During N^+_2 formation, one electron is removed from the bonding molecular orbital of N_2.

(B) During O^+_2 formation, one electron is removed from the antibonding molecular orbital of O_2.

(C) During O^-_2 formation, one electron is added to the bonding molecular orbital of O_2.

(D) During CN^- formation, one electron is added to the bonding molecular orbital of CN.