SOLVED EXAMPLES

Ex. 1 Which of the following will be strongest Lewis base ?

(A) CH_3CN **(B)** CH_3NH_2

(C) N_2 **(D)** None of these

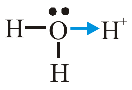
Sol. **(B)** In CH_3NH_2, hybridisation of N is sp^3 while in CH_3CN hybridisation of N is sp. N_2 is also sp hybridised.

We know that in hybridisation, as s-character increases the electronegativity of atom also increases. Due to this tendency the release of lone pair of electrons becomes some what difficult. In methyl amine the nitrogen is in sp^3 hybridisation and therefore the donation of the lone pair of electron will be quite easier; so it is strongest Lewis base.

Ex. 2 Which type of hybridisation is found in H_3O^+ ?

Sol. According to steric no. rule

Steric number = Number of bond pair(s) + number of lone pair(s) at central atom



So, steric number = 3 + 1 = 4.

Thus the hybridisation of oxygen in H_3O^+ is sp^3.

Ex. 3 Classify the following bonds as ionic, polar covalent or covalent and give your reasons :

(A) SiSi bond in $Cl_3SiSiCl_3$

(B) SiCl bond in $Cl_3SiSiCl_3$

(C) CaF bond in CaF_2

(D) NH bond in NH_3

Sol. **(A)** Covalent, due to identical electronegativity.

(B) Covalent, due to less electronegativity difference.

(C) Ionic, due to more electronegativity difference.

(D) Covalent, due to nearly similar electronegativity.

Ex. 4 **(A)** Which one has highest and lowest melting point and why?

NaCl KCl RbCl CsCl

(B) Why melting points of cesium halide (CsX) decrease in the order given below ?

CsF > CsCl > CsBr > CsI.

Sol. **(A)** NaCl will have highest lattice energy on account of the smaller Na^+ while CsCl has lowest lattice energy on account of the larger Cs^+. Hence NaCl has highest melting point and CsCl has lowest melting point .

(B) As size of anions increase their polarisability increases thus their covalent character increases and melting point decrease.

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Ex. 5 Which is **incorrect** statement ?

(A) In $CF_2=C=CF_2$ molecule all the four fluorine atoms are not in the same plane.

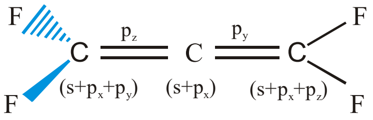
(B) Ka_2 of fumaric acid is more than Ka_2 of maleic acid due to intra molecular hydrogen bonding in maleic acid.

(C) The O–O bond length in $O_2[AsF_4]$ is longer than KO_2.

(D) The bond angle order in halogen – S – halogen is $OSF_2 < OSCl_2 < OSBr_2$

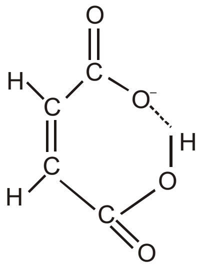
Ans. **(C)**

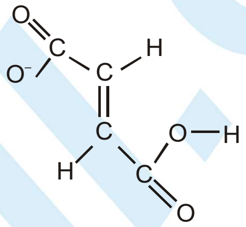
Sol. **(A)**



As both carbon atoms are in different planes, all the four fluorine atoms are not in the same plane.

(B) maleic acid fumaric acid





Due to intramolecular hydrogen bonding the maleate ion gets stabilized and thus removal of second hydrogen becomes quite difficult.

(C) $O_2[AsF_4] = O_2^+$ B.O = 2.5

$KO_2 = O_2^-$ B.O = 1.5

Bond order $\propto \dfrac{1}{\text{bond length}}$; so O_2^+ has smaller bond length than O_2^-

(D) Greater the size of the halogen atoms greater will be the steric repulsions and thus larger will be the bond angles.

Ex. 6 Which of the compounds $MgCO_3$ and $ZnCO_3$ is thermally more stable ? Explain.

Sol. Mg^{+2} has less polarising power due to inert gas configuration while Zn^{+2} has higher polarising power due to pseudo inert gas configuration. A cation i.e. Zn^{2+} with a greater, polarising power exercise a strong pull on the electron cloud of the neighbouring O-atom of the CO_3^{2-} ion and as such the metal carbonate ($ZnCO_3$) gets readily decomposed into CO_2 and the oxide of the metal, ZnO. Thus $ZnCO_3$ is less stable than $MgCO_3$.

Ex. 7 Why is anhydrous HCl predominantly covalent in the gaseous state but is ionic in aqueous solution?

Sol. It exists as HCl (bond formed by equal sharing of electrons) but in aqueous solution ionises as H^+ (or H_3O^+) and Cl^- due to polarity of HCl.

Ex. 8 Super oxides are coloured and paramagnetic why ?

Sol. Super oxides contain one unpaired electron in anti bonding molecular orbital and are coloured due to transition of HOMO orbital electron within visible region.

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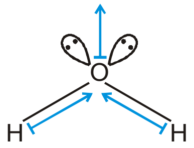
Ex. 9 Of the species O_2^+, O_2^-, O_2 and O_2^{2-} which would have the maximum bond strength ?

Sol. O_2^+ has higher bond order i.e. 2.5 than O_2(2) and O_2^- (1.5) and bond strength is directly proportional to bond order.

Ex. 10 Why BeF_2 has zero dipole moment whereas H_2O has some dipole moment ?

Sol. BeF_2 has linear molecule and H_2O has bent molecule.

$\mu = 0$



$\mu \neq 0$

Ex. 11 A diatomic molecule has a dipole moment of 1.2 D. If its bond distance is equal to 1.0Å then the fraction of an electronic charge on each atom is :

(A) 25% **(B)** 37%

(C) 52% **(D)** 42%

Ans. **(A)**

Sol. Assuming complete charge transfer then dipole moment = $(4.8 \times 10^{-10}$ esu) $(10^{-8}$ cm) = 4.8 D

so % ionic character $= \frac{1.2}{4.8} \times 100\,\% = 25\%$

Ex. 12 Why crystals of hydrated calcium sulphate are soft and easily cleaved where as anhydrous calcium sulphate are very hard and very difficult to cleave ?

Sol. With in the Ca^{2+} / SO_4^{2-} layer the ions are held together by strong electrovalent bonds but these separated Ca^{2+} / SO_4^{2-} layers are linked by relative weak H–bond. The weak H-bonds link SO_4^{2-} ion in the intermediate region.

Ex. 13 The dipole moment of KCl is 3.336×10^{-29} Coulomb meter. The interionic distance in KCl is 2.6Å. Find the % ionic character in KCl.

Sol. The theoretical dipole moment in KCl $= e \times d = 1.602 \times 10^{-19} \times 2.6 \times 10^{-10} = 4.1652 \times 10^{-29}$ C meter

% ionic character $= \frac{\text{experimental dipole moment}}{\text{theoretical dipole moment}} \times 100 = (3.336 \times 10^{-29}/4.1652 \times 10^{-29}) \times 100$

Ex. 14 For an ionic compound AX_3 (s) formed between a metal A and a non-metal X (outermost shell configuration of $X = ns^2 np^5$). Find the enthalpy of formation (magnitude) of AX_3(s) in k cal mol^{-1} with the help of the following data. (Non-metal X is found to exist in nature as a diatomic gas)

$\Delta H_{\text{Sublimation}}$ A(s) = 100 Kcal/mol

ΔH_{IE_1} A(g) = 60 Kcal/mol

ΔH_{IE_2} A (g) = 150 Kcal/mol

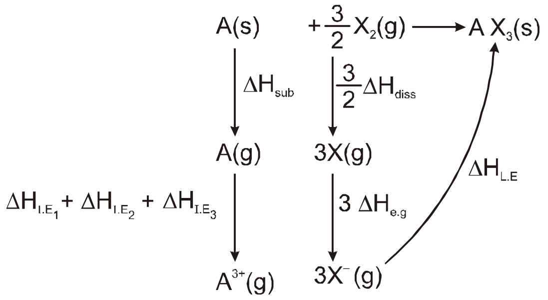
ΔH_{IE_3} A(g) = 280 Kcal/mol

ΔH_{diss} X_2(g) = 80 Kcal/mol

$\Delta H_{\text{e.g}}$ X(g) = – 110 Kcal/mol

$\Delta H_{\text{Lattice energy}}$ AX_3(s) = – 470 Kcal/mol

Sol.



$$\Delta H_f = \Delta H_{sub} + \Delta H_{I.E_1} + \Delta H_{I.E_2} + \Delta H_{I.E_3} + \frac{3}{2}\ \Delta H_{diss} + 3\ \Delta H_{e.g} + \Delta H_{L.E}$$

$$= 100 + 60 + 150 + 280 + \frac{3}{2} \times 80 - 3 \times 110 - 470 = 100 + 60 + 150 + 280 + 120 - 330 - 470$$

$= -90$ Kcal/mol **Ans.**

Ex. 15 CO forms weak bonds to Lewis acid such as BF_3. In contrast CO forms strong bonds to transition metals. Why explain ?

Sol. $CO \xleftarrow[\sigma]{} BF_3$

Transition metal $\underset{\sigma}{\overset{\pi}{\rightleftarrows}}$ CO

This is called synergic interaction and because of it the bond between CO and transition metal is stronger.

Ex. 16 The gaseous potassium chloride molecule has a measured dipole moment of 10.0 D, which indicates that it is a very polar molecule. The separation between the nuclei in this molecule is 2.67×10^{-8} cm. Calculate the percentage ionic character in KCl molecule.

Sol. Dipole moment of compound would have been completely ionic

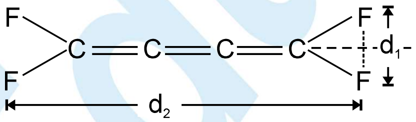
$$= (4.8 \times 10^{-10}\ \text{esu})\ (2.67 \times 10^{-8}\ \text{cm}) = 12.8\ \text{D}$$

so % ionic character $= \frac{10.0}{12.8} \times 100\% = 78.125\ \% \simeq 78\%$ **Ans.**

Ex. 17 There will be three different fluorine-fluorine distances in molecule $CF_2\,(C)_2\,CF_2$. Assuming ideal bond angles for a particular hybridisation (assume no distortion due to double bonds) find out the two smaller fluorine-fluorine distances and fill the result (in pm) in the increasing order in your answer sheet. Round off your answer to the nearest whole number.

(Given that C–F bond length = 134 pm, C = C bond length = 134 pm $\sqrt{3}$ = 1.73)

Sol.



$d_1 = 2 \times 134 \times \sin 60°$ pm = 231.8 pm = 232 pm

$d_2 = 134 \times 3 + 2 \times 134 \cos 60°$ pm = 536 pm **Ans.**

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Exercise # 1

[Single Correct Choice Type Questions]

1. Electrovalent compound's
(A) Melting points are low
(B) Boiling points are low
(C) Conduct current in fused state
(D) Insoluble in polar solvent

2. An element has electronegativity 1. The bonds formed between atoms of this elements are
(A) covalent **(B)** metallic **(C)** ionic **(D)** hydrogen bond

3. Which of the following compound has electrovalent linkage ?
(A) CH_3Cl **(B)** NaCl **(C)** CH_3OH **(D)** CH_3COOH

4. An ionic bond $A^+ B^-$ is most likely to be formed when :
(A) the ionization energy of A is high and the electron affinity of B is low
(B) the ionization energy of A is low and the electron affinity of B is high
(C) the ionization energy of A and the electron affinity of B is high
(D) the ionization energy of A and the electron affinity of B is low

5. Among the following which property is commonly exhibited by a covalent compound
(A) High solubility in water
(B) High electrical conductance
(C) Low boiling point
(D) High melting point

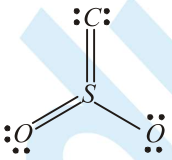
6. Given the electronegativities of three elements X = 1.0, Y = 2.0, Z = 3.0. The type of bonding formed between XZ and YZ respectively would be :
(A) Covalent, ionic
(B) Ionic, covalent
(C) Covalent, covalent
(D) Ionic, ionic.

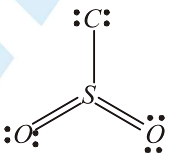
7. Which of the following pairs of elements forms a compound with maximum ionic character ?
(A) Na and F **(B)** Cs and F **(C)** Na and C **(D)** Cs and I

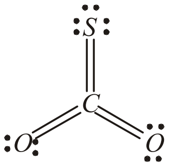
8. Example of super octet molecule is :
(A) SF_6 **(B)** PCl_5 **(C)** IF_7 **(D)** All of these

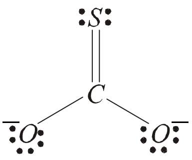
9. Average bond order of C–C bond in C_6H_6 is
(A) 1 **(B)** 2 **(C)** 1.5 **(D)** 1.33

10. The possible structure of monothiocarbonate ion is :

(A)


(B)


(C)


(D)


11. Which one (s) of the following structures cannot represent resonance forms for N_2O (diamagnetic)?
(A) $:\ddot{N}=N=\ddot{O}:$ (B) $:N\equiv N-\underset{\cdot\cdot}{\ddot{O}}:$ (C) $:\underset{\cdot\cdot}{\ddot{N}}-N\equiv O:$ (D) $:\ddot{N}=O=\ddot{N}:$ (E) $:\underset{\cdot}{\dot{N}}=N=\underset{\cdot}{\dot{O}}:$
(A) A and C **(B)** C , E and D **(C)** D and E **(D)** C and D.

12. The octet rule is not obeyed in :
(A) CO_2 **(B)** BCl_3 **(C)** PCl_5 **(D)** **(B)** and **(C)** both

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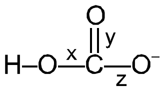
13. Which of the following compounds does not contain –1 formal charge on any of O atom :
(A) O_3 **(B)** H_3PO_4 **(C)** HNO_3 **(D)** N_2O_5

14. Pick out among the following species isoelectronic with CO_2.
(A) N_3^- **(B)** $(CNO)^-$ **(C)** $(NCN)^{2-}$ **(D)** All of these

15. 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)** $CO < CO_2 < CO_3^{2-}$

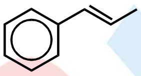
16. The average charge on each O atom and average bond order of I–O bond in IO_6^{5-} is :
(A) –1 and 1.67 **(B)** – 5/6 and 1.67 **(C)** –5/6 and 1.33 **(D)** –5/6 and 1.167

17. 

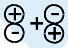
$H{-}O\overset{x}{-}\overset{\overset{O}{\|}\,y}{C}\underset{z}{-}O^-$ The relation between x, y and z in bicarbonate ion with respect to bond length is :
(A) $x > y > z$ **(B)** $x > z > y$ **(C)** $z = y > x$ **(D)** $x > y = z$

18. 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

19. 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

20. How many bonds are there in  ?
(A) 13 **(B)** 23 **(C)** 20 **(D)** 26

21. 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

22. Effective overlapping will be shown by :
(A) ⊕⊖+⊕⊖ **(B)**  **(C)** ⊕⊖+⊖⊕ **(D)** All the above

23. The covalency of nitrogen in HNO_3 is
(A) 0 **(B)** 3 **(C)** 4 **(D)** 5

24. What is covalency of I in IF_7 ?
(A) 5 **(B)** 3 **(C)** 7 **(D)** 1

25. 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^+

26. 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

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27. Which of the following has been arranged in increasing order of size of the hybrid orbitals ?

(A) $sp < sp^2 < sp^3$ **(B)** $sp^3 < sp^2 < sp$

(C) $sp^2 < sp^3 < sp$ **(D)** $sp^2 < sp < sp^3$

28. The hybridization of carbon atoms in $C_2 - C_3$ single bond of $\overset{4}{HC} \equiv \overset{3}{C} - \overset{2}{C}H = \overset{1}{C}H_2$ is :

(A) $sp^3 - sp^3$ **(B)** $sp^2 - sp$ **(C)** $sp - sp^2$ **(D)** $sp^3 - sp$

29. Specify the hybridisations of central atom in the following species respectively $\{N_3^-, NOCl, N_2O\}$

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

30. In which of the following pairs hybridisation of the central atoms are different ?

(A) ClF_3 , ClF_3O **(B)** ClF_3O, ClF_3O_2 **(C)** $[ClF_2O]^+$, $[ClF_4O]^-$ **(D)** $[ClF_4O]^-$, $[XeOF_4]$

31. $BF_3 + F^- \rightarrow BF_4^-$

What is the hybridisation state of B in BF_3 and BF_4^- :

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

32. In H_2SO_4 molecule

(A) S-atom is sp^3d^2 hybridised and there are 4 lone pair electrons on 'O' atoms.

(B) S-atom is sp^3 hybridised and there are no lone pair of electrons in the molecule.

(C) S-atom is sp^3 hybridised and there are 8 lone pair of electrons on the 'O' atoms.

(D) S-atom is sp^2 hybridised and these are 8 lone pair of electrons 'O' atoms

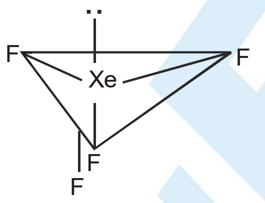
33. S_1 : $[XeF_7]^+$ has sp^3d^3 hybridisation ; S_2 : $[PCl_4]^+$ has sp^3d^2 hybridisation

S_3 : $[SF_6]$ has sp^3d^2 hybridisation ; S_4 : $[PF_4]^+$ has sp^3 hybridisation

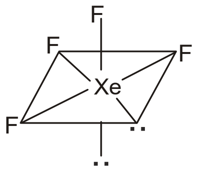
(A) T F F T **(B)** T T F T **(C)** T F T T **(D)** F F F T

34. Which is the right structure of XeF_4 ?

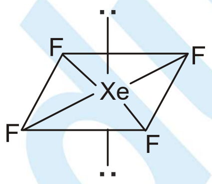
(A)



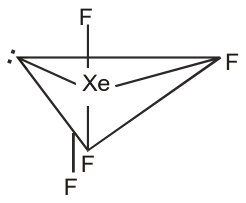
(B)



(C)



(D)



35. Which reaction involves a change in the electron–pair geometry for the under lined element ?

(A) $\underline{B}F_3 + F^- \longrightarrow \underline{B}F_4^-$ **(B)** $\underline{N}H_3 + H^+ \longrightarrow \underline{N}H_4^+$

(C) $2\,\underline{S}O_2 + O_2 \longrightarrow 2\,\underline{S}O_3$ **(D)** $H_2\underline{O} + H^+ \longrightarrow H_3\underline{O}^+$

36. In which of the following molecules number of lone pairs and bond pairs on central atom are not equal ?

(A) H_2O **(B)** I_3^- **(C)** O_2F_2 **(D)** SCl_2

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37. The structure of F_2SeO is analogous to :

(A) SO_3 **(B)** ClO^{-}_{3} **(C)** XeO_3 **(D)** **(B)** and **(C)** both

38. Which of the following species given below have shape similar to $XeOF_4$?

(A) XeO_3 **(B)** IOF_4^{+} **(C)** PCl_5 **(D)** $XeF_5^{\oplus}$

39. 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)

40. 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

41. Consider the following molecules ; H_2O (I) H_2S (II) H_2Se (III) H_2Te (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

42. In which of the following bond angle is maximum

(A) NH_3 **(B)** NH_4^{+} **(C)** PCl_3 **(D)** SCl_2

43. 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

44. In which of the following central atom is unhybridised?

(A) $S(CH_3)_2$ **(B)** SO_2 **(C)** SiH_4 **(D)** PCl_3

45. The ONO angle is maximum in :

(A) HNO_3 **(B)** NO_2^{+} **(C)** HNO_2 **(D)** NO_2

46. Which statement is correct for N_3^{-} ion

(A) It is bent molecule **(B)** Bond angle is < 120°
(C) Central atom is sp^2 hybridized **(D)** None of these

47. All the following species have all their bond lengths identical except :

(A) AsF_3 **(B)** AsF_4^{-} **(C)** AsF_4^{+} **(D)** AsF_6^{-}

48. Which of the following has maximum (C–C) bond length

(A) C_2H_2 **(B)** C_2H_4 **(C)** C_2H_6 **(D)** $C_2H_2Br_2$

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49. Consider the following statements

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

2. In ClF_3 at least one bond angle is exactly 180°

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

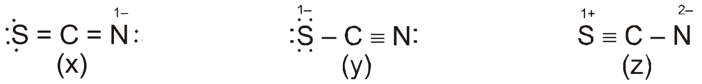
The above statements 1, 2, 3 respectively are (T = True, F = False)

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

50. Which one has highest bond angle.

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

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



$\ddot{S}=C=\overset{1-}{N}$: (x) $\quad$ $:\overset{1-}{\ddot{S}}-C\equiv N$: (y) $\quad$ $\overset{1+}{S}\equiv C-\overset{2-}{N}$ (z)

The decreasing order of % contribution in resonance hybrid is :

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

52. 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

53. 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.

54. 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

55. 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)** $4\sigma + 3\pi$

56. 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.

57. 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

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

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

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

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

60. 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)** $NO_2^- > NO_3^- > NO_2^+$

61. 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

62. Which of the following should have pyramidal shape :

(A) $[ClOF_2]^+$ **(B)** ICl_3 **(C)** $[BrICl]^-$ **(D)** All of these

63. Which of the following species have a non linear shape ?

(A) N_2O **(B)** I_3^+ **(C)** SCN^- **(D)** NO_2^+

64. The correct order of increasing $X - O - X$ bond angle is $(X = H, F \text{ or } Cl)$:

(A) $H_2O > Cl_2O > F_2O$ **(B)** $Cl_2O > H_2O > F_2O$

(C) $F_2O > Cl_2O > H_2O$ **(D)** $F_2O > H_2O > Cl_2O$

65. When NH_3 is treated with HCl, in the product species H—N—H bond angle (in comparison to ammonia)

(A) Increases **(B)** Decreases **(C)** Remains same **(D)** Depends upon temperature

66. The correct order of bond angle is :

(A) $H_2S < NH_3 < BF_3 < CH_4$ **(B)** $NH_3 < H_2S < CH_4 < BF_3$

(C) $H_2S < NH_3 < CH_4 < BF_3$ **(D)** $H_2S < CH_4 < NH_3 < BF_3$

67. Arrange the following in the increasing order of deviation from normal tetrahedral angle :

(A) $P_4 < PH_3 < H_2O$ **(B)** $PH_3 < H_2O < P_4$ **(C)** $P_4 < H_2O < PH_3$ **(D)** $H_2O < PH_3 < P_4$

68. In XeF_2 molecule the angle between two lone pair orbitals is α, the angle between lone pair orbital and bond pair orbital is β and the angle between bond pair orbitals is γ :

(A) $\alpha = \beta = \gamma$ **(B)** $\alpha > \beta > \gamma$ **(C)** $\gamma > \beta > \alpha$ **(D)** $\gamma > \alpha > \beta$

69. The hybridisation of P in phosphate ion (PO_4^{3-}) is the same as :

(A) I in ICl_4^- **(B)** S in SO_3 **(C)** N in NO_3^- **(D)** S in SO_3^{2-}

70. Choose the molecules in which hybridisation occurs in the ground state ?

(A) BCl_3 **(B)** NH_3 **(C)** PCl_3 **(D)** BeF_2

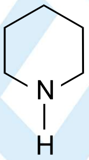
The correct answer is :

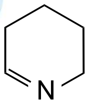
(A) a, b, d **(B)** a, b, c **(C)** b, c **(D)** c, d

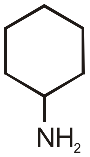
71. Phosphorous penta-chloride in gaseous phase exists as a monomer. In solid state, it exists as PCl_4^+ and PCl_6^- ions. The hybrid state of P-atom in PCl_5 is sp^3d. The hybrid states of P–atoms in PCl_4^+ and PCl_6^- will be :

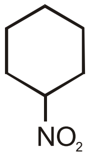
(A) sp^3d, sp^3d^2 **(B)** sp^3,sp^3d^2 **(C)** sp^3d^2, sp^3d **(D)** sp^3,sp^3d

72. In which of the following cyclic compound the nitrogen atom is sp^3 hybridised

(I)


(II)


(III)


(IV)


(A) I & III **(B)** I, II, III **(C)** III & IV **(D)** I, III & IV

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73. The bent or V–shape of the molecule can be resulted from which of the following hybridization.
(A) sp^3
(B) sp^2
(C) Both **(A)** and **(B)**
(D) None of these

74. In which of the following molecules are all the bonds not equal?
(A) NF_3
(B) ClF_3
(C) BF_3
(D) AlF_3

75. Which of the following is correct order of bond length ?
(A) $BF_4^- < BF_3$
(B) $NO_2^+ < NO_2^-$
(C) $CCl_4 < CF_4$
(D) $^+CH_3 > CH_4$

76. In which of the following cases the stated bond is longer in first species than in second species?
(A) C– H bond in cyclopropane and propane
(B) Equatorial P –Cl bond in PCl_5 and P–Cl bond in PCl_6^-
(C) N – N bond in N_2O_4 and N– N bond in N_2H_4
(D) C – C bond in benzene and C_2H_6

77. Identify the correct statement :
(A) single N–N bond is stronger than single P – P bond
(B) single N–N bond is weaker than single P – P bond
(C) $N \equiv N$ is weaker than $P \equiv P$
(D) None of these

78. In O_2F_2, which of the following statement is incorrect.
(A) O–F bond length in O_2F_2 is longer than O–Fbond length in OF_2.
(B) The O.N. of oxygen in O_2F_2 is +1.
(C) The O–O bond length in O_2F_2 is shorter than O–O bond length in H_2O_2.
(D) None of these

79. A σ bonded molecule MX_3 is T-shaped. The number of non-bonding pairs of electrons can be
(A) 0
(B) 2
(C) 1
(D) none of these

80. Which of the following pairs does not contain isomorphous species :
(A) $BaSO_4$, $KMnO_4$
(B) $KClO_4$, KBF_4
(C) $FeSO_4.7H_2O$, $MgSO_4.7H_2O$
(D) $NaClO_3$, $NaNO_3$

81. Boron forms covalent compound due to
(A) Small size
(B) Higher ionization energy
(C) Lower ionization energy
(D) Both **(A)** and **(B)**

82. To which of the following species is the octet rule applicable ?
(A) BrF_5
(B) SF_6
(C) IF_7
(D) CO_2

83. 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.

84. 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

85. 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

86. Which of the following overlaps gives a σ bond with x as internuclear axis?

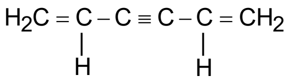
(A) p_z and p_z **(B)** s and p_z **(C)** s and p_x **(D)** $d_{x^2-y^2}$ and $d_{x^2-y^2}$

87. 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

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

(A) All the carbon in  $\underset{}{H_2C}=\underset{|\atop H}{C}-C\equiv C-\underset{|\atop H}{C}=CH_2$ 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.

89. 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.

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

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

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

91. 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

92. 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

93. 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

94. 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)** $ClO_2 > H_2O > H_2S > SF_6$

95. 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

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96. 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

97. **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

98. 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

99. 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

100. 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°

101. 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

102. 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

103. 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)** $H_2 + I_2$

104. Which of the following contains a coordinate covalent bond
(A) HNO_3 **(B)** $BaCl_2$ **(C)** HCl   **(D)** H_2O

105. 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

106. Identify the species containing Banana bonds
(A) $(BeH_2)_n$ **(B)** BF_3 **(C)** $(AlCl_3)_2$ **(D)** $(BeCl_2)_n$

107. 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

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

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

109. 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.

110. 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

111. 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.

112. 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 $BF_3 > BCl_3 > BBr_3$

113. 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)** $p_x + p_x$

114. 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.

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

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

116. 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

117. 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

118. 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

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

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

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

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

121. Which of the following species is paramagnetic ?

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

122. 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

123. 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}

124. Which one is paramagnetic from the following

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

125. 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

126. 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.

127. S_1 : The HOMO in F_2^- is $\pi 2p_x = \pi 2p_y$ molecular orbitals.

S_2 : Bond order of O_2^- is more then O_2^+ .

S_3 : NO^+ is more stable than N_2^+

S_4 : C_2 is more stable than C_2^+

State, in order, whether S_1, S_2, S_3, S_4 are true or false

(A) FFFT **(B)** FTTT **(C)** FTFT **(D)** FFTT

128. Which the following molecules / species have identical bond order and same magnetic properties ?

(I) O_2^+ ; (II) NO ; (III) N_2^+

(A) (I) , (II) only **(B)** (I) and III only **(C)** (I) ,(II) and (III) **(D)** (II) and (III) only

129. Which of the following species does not contain N – N covalent bond ?

(A) N_2O_3 **(B)** $N_2O_2^{2-}$ **(C)** N_2O_5 **(D)** N_2O_4

130. Which statement is **incorrect** about pyrosilicate ion.

(A) sp^3 hybridisation **(B)** One oxygen atom is shared between two tetrahydron

(C) there are eight Si–O bond **(D)** There is one Si-Si bond

131. The specie which does not contain an odd number of valence electrons and is diamagnetic:

(A) NO **(B)** NO_2 **(C)** ClO_2 **(D)** N_2O_4

132. Which is correct about the cyclic silicate $[Si_6O_{18}]^{n-}$:

(A) The value of n is 12
(B) each Si atom is bonded with three oxygen atoms
(C) each oxygen atom is bonded with two Si atoms
(D) all the above are correct.

133. The no. of S-O-S bonds in the trimer of SO_3 is

(A) 1 **(B)** 2 **(C)** 3 **(D)** None

134. Which of the following species do not contain S–S linkage?

(A) $H_2S_2O_5$ **(B)** $H_2S_2O_7$ **(C)** $H_2S_2O_3$ **(D)** $H_2S_4O_6$

135. Number of sigma bonds in P_4O_{10} is :

(A) 6 **(B)** 7 **(C)** 17 **(D)** 16

136. In which of the following compounds B – F bond length is shortest ?

(A) BF_4^- **(B)** $BF_3 \rightarrow NH_3$ **(C)** BF_3 **(D)** $BF_3 \leftarrow N(CH_3)_3$

137. Number of antibonding electrons in N_2 is :

(A) 4 **(B)** 10 **(C)** 12 **(D)** 14

138. Consider the following statements.

S_1 : Fluorine does not form any polyhalide because it does not have d-orbitals in valence shell.
S_2 : In ClF_3 , the three lone pairs of electrons occupy the equatorial position.
S_3 : In B_2 and N_2 molecules mixing of s- and p- atomic orbitals takes place.
Of these statements :

(A) S_1 , S_2 and S_3 are correct **(B)** S_1 and S_2 are correct
(C) S_1 and S_3 are correct **(D)** S_2 and S_3 are correct

139. Which of the following has the minimum heat of dissociation of $N \rightarrow B$ bond ?

(A) $[(CH_3)_3N \rightarrow BF_3]$ **(B)** $[(CH_3)_3N \rightarrow B(CH_3)F_2]$
(C) $[(CH_3)_3N \rightarrow B(CH_3)_2F]$ **(D)** $[(CH_3)_3N \rightarrow B(CH_3)_3]$

140. In which of the following molecules/species all following characteristics are found ?

(A) Tetrahedral hybridisation
(B) Hybridisation can be considered to have taken place with the help of empty orbital(s).
(C) All bond lengths are identical i.e. all A – B bond lengths are identical.

(A) B_2H_6 **(B)** Al_2Cl_6 **(C)** $BeCl_2$ **(D)** BF_4^-

141. Which of the following statement is false for trisilylamine ?

(A) Three sp^2 orbitals are used for σ bonding, giving a plane triangular structure.
(B) The lone pair of electrons occupy a p-orbital at right angles to the plane triangle and this overlaps with empty p–orbitals on each of the three silicon atoms resulting in π bonding.
(C) The N–Si bond length is shorter than the expected N–Si bond length.
(D) It is a weaker Lewis base than trimethyl amine.

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142. Gaseous SO_3 molecule

(A) is planar triangular in shape with three σ-bonds from $sp^2 - p$ overlap and three π-bonds formed by one $p\pi - p\pi$ overlap and two $p\pi - d\pi$ overlap.

(B) is a pyramidal molecule with one double bond and two single bonds

(C) planar triangular in shape with two double bonds between S and O and one single bond

(D) is planar triangular in shape with three σ bonds from $sp^2 - p$ overlap and three π-bonds formed by two $p\pi - p\pi$ overlap and one $p\pi - d\pi$ overlap.

143. Among the following which one will have the largest O – O bond length ?

(A) KO_2 **(B)** O_2 **(C)** $O_2^+[AsF_6]^-$ **(D)** K_2O_2

144. According to Molecular orbital theory which of the following is correct ?

(A) LUMO level for C_2 molecule is σ_{2p_x} orbital

(B) In C_2 molecules both the bonds are π bonds

(C) In C_2^{2-} ion there is one σ and two π bonds

(D) All the above are correct

145. Which species can exist among the following :

(A) B_2 **(B)** Be_2 **(C)** Ne_2 **(D)** He_2

146. The correct order in which the O - O bond length increases in the following is :

(A) $H_2O_2 < O_2 < O_3$ **(B)** $O_2 < H_2O_2 < O_3$ **(C)** $O_2 < O_3 < H_2O_2$ **(D)** $O_3 < H_2O_2 < O_2$

147. Which of the following is a **wrong** order with respect to the property mentioned against each ?

(A) $O_2^{2-} > O_2 > O_2^+$ [Paramagnetic moment]

(B) $(NO)^- > (NO) > (NO)^+$ [bond length]

(C) $H_2 > H_2^+ > He_2^+$ [bond energy]

(D) $NO_2^+ > NO_2 > NO_2^-$ [bond angle]

148. Which of the following option with respect to increasing bond dissociation energies is correct ?

(A) $NO < C_2 < O_2^- < He_2^+$

(B) $C_2 < NO < He_2^+ < O_2^-$

(C) $He_2^+ < O_2^- < NO < C_2$

(D) $He_2^+ < O_2^- < C_2 < NO$

149. Two types of carbon-carbon covalent bond lengths are present in

(A) diamond **(B)** graphite **(C)** C_{60} **(D)** benzene

150. In which of the following species peroxide group is not present :

(A) $[B_4O_5(OH)_4]^{2-}$ **(B)** $[S_2O_8]^{2-}$ **(C)** CrO_5 **(D)** HNO_4

151. Which of the following is correct ?

(A) S_3O_9 – contains no S–S linkage.

(B) $S_2O_6^{2-}$ – contains –O–O– linkage.

(C) $(HPO_3)_3$ – contains P – P linkage

(D) $S_2O_8^{2-}$ contains S–S linkage

152. The percentage of s–character in the orbital forming P – S bonds in P_4S_3 is :

(A) 25 **(B)** 33 **(C)** 75 **(D)** 50

153. Which of the following solids is a good conductor of electricity

(A) $(BN)_x$ **(B)** SiO_2 **(C)** SiC **(D)** none of these

154. Consider the following statements ;

(I) The hybridisation found in cation of solid PCl_5 is sp^3.

(II) In AB_2L_2 type the BAB bond angle is always greater than the normal tetrahedral bond angle.

(III) In ClO_3^-, NH_3 and XeO_3, the hybridisation and the number of lone pairs on the central atoms are same.

(IV) In P_4 molecule, there are six P – P bonds and four lone pairs of electrons.

of these statements :

(A) I, II and III are correct only

(B) I, III and IV are correct only

(C) III and IV are correct only

(D) All are correct

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155. In the coordinate valency
(A) Electrons are equally shared by the atoms
(B) Electrons of one atom are shared with two atoms
(C) Hydrogen bond is formed
(D) None of the above

156. What is the nature of the bond between B and O in $(C_2H_5)_2OBH_3$
(A) Covalent
(B) Co-ordinate covalent
(C) Ionic bond
(D) Banana shaped bond

157. Which of the following statements is correct ?
(A) $N_2F_3^+$ is planar at each nitrogen atom.
(B) In N_3H, the H – N – N bond angle is exactly of 120°.
(C) The shape of $N(SiMe_3)_3$, is trigonal planar.
(D) **(A)** and **(C)** both.

158. Which of the following statement is correct for the 1 : 1 complex of trimethyl amine and boron tri fluoride ?
(A) The B - F bond length in the complex is longer than that of in BF_3.
(B) The N is pyramidal with sp^3 hybridisation and B is planar with sp^2 hybridisation.
(C) The coordination geometry of N and B both are tetrahedral with sp^3 hybridisation each.
(D) **(A)** and **(C)** both.

159. The molecular orbital configuration of a diatomic molecule is

$$\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2p_x^2 \begin{cases} \pi 2p_y^2 \\ \pi 2p_z^2 \end{cases}$$

Its bond order is
(A) 3
(B) 2.5
(C) 2
(D) 1

160. The bond order of He_2^+ molecule ion is :
(A) 1
(B) 2
(C) $\frac{1}{2}$
(D) $\frac{1}{4}$

161. Pick out the incorrect statement.
(A) N_2 has greater dissociation energy than N_2^+
(B) O_2 has lower dissociation energy than O_2^+
(C) Bond length in N_2^+ is less than N_2
(D) Bond length in NO^+ is less than in NO.

162. The species which are diamagnetic :
(A) O_2^-
(B) NO_2
(C) ClO_2
(D) N_2O_4

163. A simplified application of MO theory to the hypothetical ‘molecule’ OF would give its bond order as :
(A) 2
(B) 1.5
(C) 1.0
(D) 0.5

164. Which of the following is incorrect ?
(A) The O – O bond length in H_2O_2 is larger than that in O_2F_2.
(B) The O – O bond length in H_2O_2 is very slightly smaller than in O_2^{2-} ion.
(C) O_2^- and O_2^+ species are paramagnetic and have same number of unpaired electrons.
(D) None

165. 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....
(A) Decrease, Increases
(B) Increases ,Decrease
(C) Increases ,Increases
(D) None of these

166. In a P_4O_6 molecule, the total number of P–O–P bonds is
(A) 4
(B) 6
(C) 2
(D) 3

167. The point of dissimilarity between $(SO_3)_3$ and (HPO_3) (cyclic trimers) is.
(A) Both have six membered ring.
(B) Both contain central atom in same hybridization
(C) Both contain planar ring.
(D) Both are isoelectronic.

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168. Which of the following statements is / are correct ?

(A) Hybridisation of carbon in C_3O_2 is sp^2.

(B) In $Cr_2O_7^{2-}$, six Cr – O bonds are identical.

(C) Three centre two electron bonds exist in B_2H_6 and Al_2Cl_6 .

(D) In AgI, the colour is attributed to charge transfer spectrum.

169. Which of the following is correct :

(A) N–O bond length in NO gaseous molecule will be greater than in NOCl gaseous molecule.

(B) Carbon-carbon bond length in CaC_2 will be more than in C_2H_4

(C) O–O bond length in KO_2 will be more than in Na_2O_2 .

(D) All the four hydrogen atoms in CH_4 are not coplanar

170. Which one of the following oxides is expected exhibit paramagnetic behaviour

(A) CO_2 **(B)** SO_2 **(C)** ClO_2 **(D)** SiO_2

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Exercise # 2

Part # I [Multiple Correct Choice Type Questions]

1. Most ionic compounds have :

(A) high melting points and low boiling points
(B) high melting points and non-directional bonds
(C) high solubilities in polar solvents and low solubilities in nonpolar solvents
(D) three-dimensional crystal structures, and are good conductors of electricity in the molten state.

2. All bond :

(A) dissociations are exothermic
(B) dissociations are endothermic
(C) enthalpies are positive
(D) enthalpies are negative

3. Which of the following compounds contain(s) both ionic and covalent bonds?

(A) NH_4Cl
(B) KCN
(C) $CuSO_4 \cdot 5H_2O$
(D) NaOH

4. Which of the following statements concerning the molecule $H - C \equiv C - CH_3$ is / are not correct.

(A) It has 6σ and 2π bonds
(B) Both the π-bonds are present in the same plane
(C) The central carbon atom is sp hybridised while the terminal atoms are sp^2 hybridised
(D) The molecule is linear

5. In which of following, vacant orbital take part in hybridisation :

(A) BF_3
(B) PCl_6^-
(C) BF_4^-
(D) NH_3

6. Which is not true about VSEPR theory

(A) Lone pair-lone pair repulsion is maximum.
(B) Lone pair and double bond occupy axial position in trigonal bipyramidal structure.
(C) More electronegative atoms occupies axial position in trigonal bipyramidal structure.
(D) Bigger atoms occupy axial positions in trigonal bipyramidal structure.

7. Select the **correct** statement.

(A) Perxenate ion is $[XeO_6]^{4-}$ with octahedral geometry.
(B) XeF_2 is linear molecule with 3 lone pairs (l.p)
(C) $XeOF_4$, XeF_4, XeO_2F_2 all contains one lone pair only
(D) None of these

8. Which is/are in linear shape ?

(A) NO_2^+
(B) XeF_2
(C) I_3^-
(D) I_3^+

9. Which is true about NH_2^-, NH_3 ,NH_4^+ ?

(A) Hybridization of N is same.
(B) No. of lone pair of electron on N are same.
(C) Molecular geometry (i.e. shape) is different.
(D) Bond angle is same.

10. Identify the **correct** option(s)

(A) $NH_4^+ > NH_3 > NH_2^-$ order of bond angle
(B) $(CH_3)_3$ B is a trigonal planar molecule (not considering the H-atoms on 'C')
(C) In NH_4Cl 'N' atom is in sp^3d hybridisation
(D) In S_8 molecule a total of 16 electrons are left on all the 'S' atoms after bonding .

11. Which of the following molecule (s) has/have bond angle close to 90º ?

(A) NH_3
(B) H_2S
(C) PH_3
(D) ICl_3

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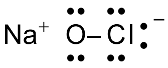
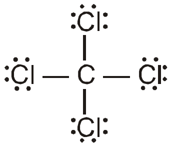
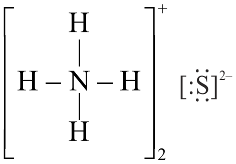
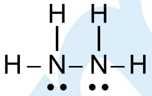
12. Which of the following Lewis diagram is/are incorrect ?

(A) 

(B) 

(C) 

(D) 

13. Hypervalent compound is(are) :
(A) SO_3^{2-} **(B)** PO_4^{3-} **(C)** SO_4^{2-} **(D)** ClO_4^-

14. Which are the exceptions of the lewis octet rule
(A) NO_3^- and N_2O **(B)** BeH_2 and NO **(C)** KrF_2 and ClF_3 **(D)** All of these

15. Which of the following overlaps is/are incorrect [assuming X-axis to be the internuclear axis] :
(a) $2p_y + 2p_y \rightarrow \pi$ (b) $2p_z + 2p_z \rightarrow \sigma$
(c) $2p_x + 2p_x \rightarrow \pi$ (d) $1s + 2p_y \rightarrow \pi$
(e) $2p_y + 2p_z \rightarrow \pi$ (f) $1s + 2s \rightarrow \sigma$
(A) 'a' & 'b' **(B)** 'b' & 'd' **(C)** 'd' & 'f' **(D)** 'c' & 'e'

16. In which of the following molecule bonding is taking place in excited state
(A) CH_4 **(B)** BF_3 **(C)** ICl_3 **(D)** PCl_3

17. Which statement is correct about hybridization ?
(A) In hybridisation orbitals take part
(B) In hybridisation electrons take part
(C) In hybridisation fully filled , half filled or empty orbitals can take part
(D) Hybridised orbitals only contains bond pair electron

18. Which of the following represent the given mode of hybridisation $sp^2 - sp^2 - sp - sp$ from left to right
(A) $H_2C=C=C=CH_2$ **(B)** $HC\equiv C-C\equiv CH$
(C) $H_2C=CH-C\equiv N$ **(D)** $H_2C=CH-C\equiv CH$

19. Which of the following is/are electron deficient compounds ?
(A) $NaBH_4$ **(B)** B_2H_6 **(C)** $AlCl_3$ **(D)** $LiAlH_4$

20. Which of the following statements is/are correct ?
(A) Out of trimethylamine and trimethylphosphine, trimethylamine has higher dipole moment.
(B) Out of $(SiH_3)_2O$ and $(CH_3)_2O$, $(SiH_3)_2O$ is more basic.
(C) C – C bond length (in pm) in C_2 molecule is greater than O – O bond length in O_2 molecule.
(D) $N(SiMe_3)_3$ and BF_3 molecules are isostructural.

21. The species which are paramagnetic is/are :
(A) NO **(B)** NO_2 **(C)** ClO_2 **(D)** N_2O_4

22. Which of the following reactions is/are likely to be impossible.
(A) $(CH_3)_2O + BF_3 \rightarrow$ **(B)** $(SiH_3)_2O + BF_3 \rightarrow$ **(C)** $(SiH_3)_3N + BF_3 \rightarrow$ **(D)** All the above

23. Which of the following have bond order three ?
(A) O_2^{2+} **(B)** NO^+ **(C)** CN^- **(D)** CN^+

24. Which of the statement(s) are correct ?
(A) There is a single bond in FO^+
(B) The F and O are further apart in FO^- than in FO^+.
(C) There is a double bond in FO^-.
(D) It would take more energy to break F – O bond in FO^+ than in FO^-.

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25. Which of the following statements is incorrect about P_4O_{10} molecule ?
(A) Each ‘P’ atom can be considered to be sp^3 hybridised
(B) There are six POP bonds in the molecule
(C) There are two types of P— O bond lengths
(D) $P\hat{O}P$ angle is 180°.

26. Which of the following statements is /are true for P_4S_3 molecule ?
(A) It contains six P–S bonds and three P–P bonds.
(B) It contains six P–S bonds and ten lone pairs.
(C) It has all atoms sp^3 hybridised.
(D) It contains six P–P bonds and ten lone pairs.

27. Identify the correct statement (s)
(A) in H-atom bond is formed by non direction orbital
(B) graphite behaves as conductor as well as semi conductor.
(C) in SiO_2 molecule Si-atom is sp^3 hybridised
(D) ClF_3 is hyper valent molecule.

28. Which of the following statements is /are true about the structure of fullerene (Buckminister fullerene) ?
(A) All the carbon atoms undergo sp^2 hybridisation.
(B) Remaining fourth electron at each carbon is delocalised in molecular orbitals which in turn gives aromatic character to molecule.
(C) It has a shape like rugby ball.
(D) It contains both single and double bonds and has two C–C distances of 143.5 pm and 138.3 pm respectively.

29. Identify the correct statement
(A) $H_2S_2O_7$ has peroxy linkage
(B) $H_2S_2O_6$ has S–S linkage
(C) $H_2S_2O_8$ has peroxy linkage
(D) H_2SO_3(Sulphurous acid) has S in +4 oxidation state

30. Identify **correct** order of bond angles
(A) $Cl_2O > F_2O$ and $F_2O < H_2O$
(B) $AsI_3 > AsBr_3 > AsCl_3$
(C) $NO_2^+ > NO_2^-$
(D) $H_b\hat{B}H_b > H_t\hat{B}H_t$; where H_t is terminal Hydrogen of B_2H_6 and H_b is the bridging Hydrogen of B_2H_6

31. Choose the **correct** options.
(A) In N_2H_4, the N–N, bond length is greater than expected value.
(B) In trisilyl amine $(SiH_3)_3N$, the Si–N bond length is lesser than expected value.
(C) The bond angle in OF_2 is lesser than OCl_2.
(D) The Be atom in $BeCl_2$(s) is sp^3 hybridised.

32. In the following, identify the incorrect statements.
(A) $N_2F_3^+$ is a planar at each nitrogen atom
(B) In F_2 molecule, the energy of $\sigma\ 2p_z$ is more than $\pi\ 2p_x$ and $\pi\ 2p_y$.
(C) The O–O bond length in H_2O_2 is smaller than in O_2F_2 .
(D) B_2, O_2 and F_2 are paramagnetic molecules.

33. Among the following, the species with one unpaired electron are :
(A) O_2^+
(B) NO
(C) O_2^-
(D) B_2

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34. Which of the following factors do not favour electrovalency ?

(A) Low charge on ions
(B) High charge on ions
(C) Large cation and small anion
(D) Small cation and large anion

35. Which statement(s) is/are correct ?

(A) Polarising power refers to cation.
(B) Polarisability refers to anion.
(C) Small cation is more efficient to polarise anion.
(D) Molecules in which cation having pseudo inert gas configuration are more covalent.

36. Which of the following is/are correct statement(s).

(A) Increasing covalent character : $NaCl < MgCl_2 < AlCl_3$
(B) Increasing covalent character : $LiF < LiCl < LiBr < LiI$.
(C) Increasing polarizability : $F^- < Cl^- < Br^- < I^-$
(D) Decreasing ionic nature : $MCl_3 > MCl_2 > MCl$

37. Which of the following statements is / are true for the metallic bond ?

(A) It is an electrical attraction between delocalised electrons and the positive part of the atom.
(B) Transition metals may use inner d– electrons along with the outer s–electrons for metallic bonding.
(C) Strength of metallic bond does not depend on the type of hybrid orbitals participating in metallic bonding.
(D) Strength of metallic bond is inversely proportional to the radius of metallic atom.

38. Which of the following statements are correct ?

(A) PbI_2 is yellow due to high polarization of Pb^{2+}

(B) Beryllium chloride exists in a polymeric chain like structure in solid state.

(C) The thermal stability of alkalline earth metal carbonates follow the order :
$BeCO_3 < MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$

(D) CuI has higher covalent character than NaI.

39. The halogen form compounds among themselves with formula XX', XX'_3, XX'_5 and XX'_7 where X is the heavier halogen. Which of the following pairs representing their structures and being polar and non-polar are correct?

(A) XX' – Linear – polar
(B) XX'_3 – T-shaped – polar
(C) XX'_5 – square pyramidal – polar
(D) XX'_7 – Pentagonal bipyramidal – non-polar

40. Which of the following is/are correct statement(s) for dipole moment ?

(A) Lone pair of electrons present on central atom can give rise to dipole moment.
(B) Dipole moment is vector quantity.
(C) CO_2 molecule has dipole moment.
(D) Difference in electronegativities of combining atoms can lead to dipole moment.

41. Which of the following molecules have intermolecular hydrogen bonds ?

(A) KH_2PO_4
(B) H_3BO_3
(C) $C_6H_2CO_2H$
(D) CH_3OH

42. Which is **correct** statement :

(A) Borazine has higher intermolecular force of attraction as compared to benzene.
(B) Ka_2 fumaric acid is more than Ka_2 of maleic acid due to intra molecular hydrogen bonding in maleic acid.
(C) The O – O bond length in $O_2[AsF_4]$ is shorter then KO_2.
(D) The bond angle order in halogen – S – halogen is $OSF_2 < OSCl_2 < OSBr_2$

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43. Select the correct statement(s).

(A) Br_2 and ICl have the same number of electrons and thus both have nearly the same boiling points.

(B) N_2H_4 is pyramidal about each N-atom.

(C) In P_4S_3 molecule, there are six P-S bonds, three P-P bonds and ten lone pairs of electrons (on all atoms).

(D) In ClO_4^-, all Cl – O bonds are identical and there is strong $p\pi - d\pi$ bonding between chlorine and oxygen atoms.

44. Which of following is correct

(A) $PH_3 < AsH_3 < SbH_3 < NH_3$	order of boiling point
(B) $D_2O(s) > H_2O(\ell)$	order of density
(C) Mn > Ca > Sr > Rb	order of metallic bond strength
(D) $H_2 < CO_2 < H_2O$	increasing order of intermolecular forces of attraction

45. Which of the following statements is/are correct :

(A) Individual oxidation number of two sulphur atoms in thiosulphate ($S_2O_3^{2-}$) ion are +4 and 0, however the average oxidation number of sulphur is +2.

(B) The reason for $Ka_2 <<< Ka_1$ for peroxymonosulphuric acid is, intramolecular H–bonding in the anion of acid after first ionisation.

(C) NH_3 has a higher boiling point than SbH_3, because of H–bonding between NH_3 molecules.

(D) Among HCl, HBr and HI, HI is the strongest acid while HCl is the weakest acid while among HOCl, HOBr and HOI, HOCl is the strongest acid while HOI is the weakest acid.

46. Which of the following statements is **correct** regarding phosphoric acid ?

(A) $p\pi - d\pi$ back bonding exist between O and P

(B) The anion is resonance stablized

(C) It is a dibasic acid

(D) Inter molecular H bonding between molecules make it a syrupy (viscous) liquid.

47. The critical temperature of water is higher than that of O_2 because the H_2O molecule has :

(A) fewer electrons than O_2 **(B)** two covalent bonds

(C) V - shape **(D)** dipole moment

48. Which of the following are polar ?

(A) XeF_4 **(B)** XeF_6 **(C)** $XeOF_4$ **(D)** XeF_5^-

49. Which of the following statement(s) is/are correct?

(A) Ethyne gas is more soluble in acetone than in water.

(B) CH_3F is more polar than CD_3F due to deuterium (D) being less electronegative than hydrogen (H).

(C) Silyl isocyanate (SiH_3NCO) is linear in shape while methyl isocyanate (CH_3NCO) is bent in shape.

(D) All of these

50. In which of the following compounds B atoms are in sp^2 and sp^3 hybridisation states ?

(A) Borax **(B)** Diborane **(C)** Borazole **(D)** All

51. **(a)** There are only 12 bonding electrons available in one molecule of diborane.

(b) $B_3N_3H_6$ is an electron deficient compound.

(c) Al_2Cl_6 sublimes on heating and give $AlCl_3$ vapours at high temperature.

(d) In $Si_2O_7^{6-}$ anion, one oxygen of a SiO_4^{4-} tetrahedron is shared with another SiO_4^{4-} tetrahedron.

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

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52. The correct order of decreasing polarizability of ion is :

(A) Cl^-, Br^-, I^-, F^- **(B)** F^-, I^-, Br^-, Cl^-

(C) I^-, Br^-, Cl^-, F^- **(D)** F^-, Cl^-, Br^-, I^-

53. Which of the following is in order of increasing covalent character ?

(A) $CCl_4 < BeCl_2 < BCl_3 < LiCl$ **(B)** $LiCl < CCl_4 < BeCl_2 < BCl_3$

(C) $LiCl < BeCl_2 < BCl_3 < CCl_4$ **(D)** $LiCl < BeCl_2 < CCl_4 < BCl_3$

54. Which of the following combination of ion will have highest polarisation ?

(A) Fe^{2+}, Br^- **(B)** Ni^{4+}, Br^- **(C)** Ni^{2+}, Br^- **(D)** Fe, Br^-

55. $SnCl_4$ is a covalent liquid because :

(A) electron clouds of the Cl^- ions are weakly polarized to envelop the cation.
(B) electron clouds of the Cl^- ions are strongly polarized to envelop the cation.
(C) its molecules are attracted to one another by strong van der Waals forces.
(D) Sn shows inert pair effect.

56. Which of the following has highest melting point according to Fajan's rule :

(A) NaCl **(B)** $MgCl_2$ **(C)** $AlCl_3$ **(D)** LiCl

57. Iron is harder than sodium because :

(A) iron atoms are smaller. **(B)** iron atoms are more closely packed.
(C) metallic bonds are stronger in sodium. **(D)** metallic bonds are stronger in iron.

58. The enhanced force of cohesion in metals is due to

(A) The covalent linkages between atoms
(B) The electrovalent linkages between atoms
(C) The lack of exchange of valency electrons
(D) The delocalization of valence electron between metallic kernels.

59. In the following metals which one has lowest probable interatomic forces

(A) Copper **(B)** Silver **(C)** Zinc **(D)** Mercury

60. Which of the following cannot be explained on the basis of Fajan's Rules ?

(A) Ag_2S is much less soluble than Ag_2O **(B)** $Fe(OH)_3$ is much less soluble than $Fe(OH)_2$

(C) $BaCO_3$ is much less soluble than $MgCO_3$ **(D)** Melting point of $AlCl_3$ is much less than that of NaCl

61. The correct order of the increasing ionic character is :

(A) $BeCl_2 < MgCl_2 < CaCl_2 < BaCl_2$ **(B)** $BeCl_2 < MgCl_2 < BaCl_2 < CaCl_2$

(C) $BeCl_2 < BaCl_2 < MgCl_2 < CaCl_2$ **(D)** $BaCl_2 < MgCl_2 < CaCl_2 < BeCl_2$

62. Which of the following compounds of elements in group IV is expected to be most ionic ?

(A) $PbCl_2$ **(B)** $PbCl_4$ **(C)** CCl_4 **(D)** $SiCl_4$

63. Least melting point is shown by the compound :

(A) $PbCl_2$ **(B)** $SnCl_4$ **(C)** NaCl **(D)** $AlCl_3$

64. Which of the following is observed in metallic bonds ?

(A) Mobile valence electrons **(B)** Localised electrons
(C) Highly directed bond **(D)** None of these

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65. **S1 :** AgI is less soluble in water than AgF due to more polarisation of I^- in comparison to F^- ion.

S2 : Melting point of $BaCl_2$ is higher than the melting point of $BeCl_2$ due to greater ionic nature of $BaCl_2$.

S3 : Order of hydrated radii is : Al^{3+} (aq) > Mg^{2+} (aq) > Na^+ (aq)

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

66. CuI_2 is unstable even at ordinary temperature because :
(A) the Cu^{2+} ion with a comparatively small radius has a strong polarising power.
(B) the Cu^{2+} ion with a 17 electron outer shell has weak polarising power.
(C) the I^- ion with a larger radius has a high polarisability.
(D) both (A) and (C)

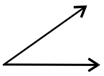
67. Which of the following statements is incorrect ?
(A) N_2 and C_2 molecules contain both σ and π bonds.
(B) Cu^{2+} is more stable than Cu^+ in aqueous medium.
(C) The electrical conductivity of metals can not be explained by electron sea model.
(D) (A) and (C) both

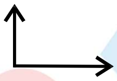
68. Which anion has the highest polarisability?

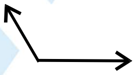
(A) I^- **(B)** Cl^- **(C)** F^- **(D)** Br^-

69. Boron forms covalent compound due to
(A) Small size **(B)** Higher ionization energy
(C) Lower ionization energy **(D)** Both (A) and (B)

70. Which has maximum dipole moment ?

(A) 

(B) 

(C) 

(D) 

71. Which of the following compounds possesses zero dipole moment?
(A) Benzene (C_6H_6) **(B)** Carbon tetrachloride
(C) Boron trifluoride **(D)** All of these

72. Of the following molecules, the one, which has permanent dipole moment, is :
(A) SiF_4 **(B)** BF_3 **(C)** PF_3 **(D)** PF_5

73. Which of the following has the least dipole moment ?
(A) NF_3 **(B)** CO_2 **(C)** SO_2 **(D)** NH_3

74. The geometry of H_2S and its dipole moment are : **[JEE–1999, 2/80]**
(A) angular and non zero **(B)** angular and zero
(C) linear and non zero **(D)** linear and zero

75. Which of the following statements is false for XeO_3F_2 ?
(A) Hybridisation of central atom xenon is sp^3d. **(B)** The compound is non-polar.
(C) The compound has $p\pi$-$d\pi$ bonding. **(D)** None.

76. The gaseous HX molecule has a measured dipole moment of 4.0 D, which indicates that it is a very polar molecule. The separation between the nuclei in this molecule is 2.67×10^{-8} cm then the percentage ionic character in HX molecule is :
(A) 78% **(B)** 31.25% **(C)** 50.25% **(D)** None of these

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77. Which of the following has been arranged in order of decreasing dipole moment ?

(A) $CH_3Cl > CH_3F > CH_3Br > CH_3I$ **(B)** $CH_3F > CH_3Cl > CH_3Br > CH_3I$

(C) $CH_3Cl > CH_3Br > CH_3I > CH_3F$ **(D)** $CH_3F > CH_3Cl > CH_3I > CH_3Br$

78. The dipole moment of chlorobenzene is 1.73 D. The dipole moment of p-dichlorobenzene is expected to be :

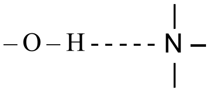
(A) 3.46 D **(B)** 0.00D **(C)** 1.73 D **(D)** 1.00 D

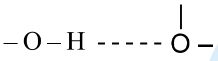
79. Which of the following models best describes the bonding within a layer of the graphite structure ?

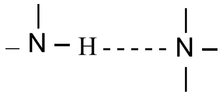
(A) metallic bonding **(B)** ionic bonding

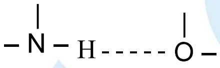
(C) non-metallic covalent bonding **(D)** van der Waals forces

80. Consider the following sets of H-bonds

P :

$-O-H\text{-----}N\!-$

Q :

$-O-H\text{-----}O\!-$

R :

$-N-H\text{-----}N\!-$

S :

$-N-H\text{-----}O\!-$

The correct order of H-bond strengths is :

(A) Q > P > S > R **(B)** R > Q > S > P

(C) R > S > P > Q **(D)** P > Q > R > S

81. Which of the following compounds would have significant intermolecular hydrogen bonding ?

HF, CH_3OH, N_2O_4, CH_4

(A) HF, N_2O_4 **(B)** HF, CH_4, CH_3OH **(C)** HF, CH_3OH **(D)** CH_3OH, CH_4

82. Which of the following is not correctly matched with respect to the intermolecular forces existing amongst the molecules (Hydrogen bonding is not taken as dipole-dipole attraction) ?

(A) Benzene – London dispresion forces

(B) Orthophosphoric acid – London dispresion force, hydrogen bonding.

(C) Hydrochloric acid – London dispresion force, dipole-dipole attraction

(D) Iodine monochloride – London dispersion force

83. Which of the following factor is responsible for van der Waals forces ?

(A) Instantaneous dipole-induced dipole interaction.

(B) Dipole-induced dipole interaction and ion-induced dipole interaction.

(C) Dipole-dipole interaction and ion-induced dipole interaction.

(D) All of these.

84. Which of the following bonds/forces is weakest ?

(A) Covalent bond **(B)** Ionic bond **(C)** Hydrogen bond **(D)** London force

85. In which of the following compound, intra–molecular H–bonding is not observed :

(A) O–hydroxy benzyaldehyde **(B)** O–nitrophenol

(C) Chloral hydrate **(D)** Boric acid

86. Which of the following statement is not true ?

(A) CCl_4 has higher boling point that $CHCl_3$.

(B) The HF_2^- ion exists in the solid state and in liquid HF solution , but not in dilute aqueous solutions.

(C) Hydrogen bonding maintains the planar H_3BO_3 units in layers in solid state.

(D) None of these.

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87. Which is correct about D_2O

(A) Its boiling point is higher than that of H_2O (l)

(B) O – D - - - - O bond is stronger than O – H - - - - O bond.

(C) D_2O(s) sinks in H_2O (l).

(D) all the above are correct.

88. Amongst NH_3, PH_3, AsH_3 and SbH_3 the one with highest boiling point is :

(A) NH_3 because of lower molecular weight **(B)** SbH_3 because of higher molecular weight

(C) PH_3 because of H-bonding **(D)** AsH_3 because of lower molecular weight

89. **S1 :** In the solid $B(OH)_3$ units are hydrogen bonded together into two-dimensional sheets with almost hexagonal symmetry.

S2 : Na_2CO_3 can be isomorphous with Na_2SO_3 as both have similar formula type.

S3 : XeO_3F_2 has one lone pair of electron on central xenon atom.

S4 : D_2O has higher boiling point than H_2O

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

90. The correct order of boiling point is :

(A) $H_2O < H_2S < H_2Se < H_2Te$ **(B)** $H_2O > H_2Se > H_2Te > H_2S$

(C) $H_2O > H_2S > H_2Se > H_2Te$ **(D)** $H_2O > H_2Te > H_2Se > H_2S$

91. Which of the following compounds has the highest boiling point

(A) HCl **(B)** HBr **(C)** H_2SO_4 **(D)** HNO_3

92. If molecule MX_3 has Zero dipole moment, the hybrid orbitals used by M (Atomic No. < 21) are

(A) Pure p **(B)** sp hybrid **(C)** sp^2 hybrid **(D)** sp^3 hybrid

93. Which of the following would be expected to have a dipole moment of zero on the basis of symmetry?

(A) $SOCl_2$ **(B)** OF_2 **(C)** SeF_6 **(D)** ClF_5

94. Among the XeF_2, SF_2Cl_2, $XeOF_2$, ICl_2^- , $IOCl_4^-$ and F_2ClO^{+1}

S1 : XeF_2, ICl_2^- , $XeOF_2$ have zero dipole moment

S2 : $IOCl_4^-$ and F_2ClO^{+1} have different electronic arrangement (geometry) at central atom

S3 : SF_2Cl_2 , $IOCl_4^-$ and F_2ClO^+ have equal number of lone pairs of electrons at the central atom.

S4 : All bond angle in each of species , $XeOF_4$, $IOCl_4^-$, SF_2Cl_2 and F_2ClO^+ are identical

The correct order for the above statements is :

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

95. **S1 :** In CrO_5 , the oxidation number of Cr is +6.

S2 : Out of CH_3Cl and $CHCl_3$, CH_3Cl has higher dipole moment

S3 : Hybridisation of sulphur in SO_3 and in its trimer is the same, sp^2 .

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

96. Given the species N_2, CO, CN^- and NO^+ . Which of the following statement is incorrect .

(A) All the species are diamagnetic **(B)** All the species are isoelectronic

(C) All the species have dipole moment **(D)** All the species are linear

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97. Which of the following are incorrect for dipole moment ?

(A) Lone pair of elements present on central atom can give rise to dipole moment

(B) Dipole moment is vector quantity

(C) PF_5 (g) molecule has non zero dipole moment

(D) Difference in electronegativities of combining atom can lead to dipole moment

98. Which of the following orders are correct regarding mentioned properties

(A) $SO_3 < CCl_4 < XeF_2$ (Bond angle).

(B) $SOF_2 > SOCl_2 > SOBr_2$ (Bond angle)

(C) $CH_3COO^- > CO_3^{2-} > CH_3COCH_3$ (C — O bond length)

(D) $CH_3Cl > CH_3F < CD_3F$ (dipole moment).

99. CH_3Cl has more dipole moment than CH_3F because :

(A) electron affinity of chlorine is greater than that of fluorine.

(B) the charge separation is larger in CH_3Cl compared to CH_3F.

(C) the repulsion between the bond pairs and non-bonded pairs of electrons is greater in CH_3Cl than CH_3F.

(D) chlorine has higher electronegativity than fluorine.

100. **S1 :** In ozone molecule, O – O bond lengths are equal, this can be explained on the basis of resonance.

S2 : Ion-dipole attraction is responsible for hydration of ions.

S3 : Intermolecular H-bonding decreases the boiling point.

S4 : A symmetrical molecule with identical bonds have non zero dipole moment.

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

101. H - bonding is maximum in

(A) C_6H_5OH **(B)** C_6H_5COOH **(C)** CH_3CH_2OH **(D)** CH_3COCH_3

102. Give the correct order of initials T or F for following statements. Use T if statement is true and F if it is false.

S_1 : HF boils at a higher temperature than HCl

S_2 : HBr boils at lower temperature than HI

S_3 : Bond length of N_2 is less than N_2^+

S_4 : F_2 has higher boiling point than Cl_2

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

103. The increasing order of the strength of hydrogen bond in the following mentioned linkages is :

(i) O—H---S (ii) S—H---O (iii) F—H---F (iv) F—H---O

(A) (i) < (ii) < (iv) < (iii) **(B)** (ii) < (i) < (iv) < (iii) **(C)** (i) < (ii) < (iii) < (iv) **(D)** (ii) < (i) < (iii) < (iv)

104. Which one of the following does not have intermolecular H-bonding ?

(A) H_2O **(B)** o-nitro phenol **(C)** HF **(D)** CH_3COOH

105. Which of the following compounds would have significant intermolecular hydrogen bonding ?

$$HF, CH_3OH, N_2O_4, CH_4, NH_3(l)$$

(A) $HF, N_2O_4, NH_3(l)$ **(B)** HF, CH_4, CH_3OH **(C)** $HF, CH_3OH, NH_3(l)$ **(D)** $CH_3OH, CH_4, NH_3(l)$

106. Select the correct statement.

(A) The order of Xe–F bond length in various fluorides of Xenon is $XeF_2 < XeF_4 < XeF_6$

(B) PH_5 can undergo sp^3d hybridisation to have octahedral geometry.

(C) Dipole moment of CH_3F is greater than that of CH_3Cl

(D) Increasing strength of hydrogen bonding is Cl–H----Cl < N–H----N < O–H----O < F–H----F

107. Consider the following statements.

S1 : The percentage of s-character in the orbital forming S – S bonds and P – P bonds in S_8 and P_4 molecules respectively are same.

S2 : In SF_4 the bond angles, instead of being 90º and 180º are 89º and 177º respectively due to the repulsions between lone pair and bond pairs of electrons.

S3 : Aqueous H_3PO_4 is syrupy (i.e more viscous than water)

S4 : SiO_2 crystal may be considered as giant molecule in which eight-membered rings are formed with alternate silicon and oxygen atoms.

Of these :

(A) S_1 & S_4 are correct only. **(B)** S_2, S_3 & S_4 are correct only.
(C) S_1, S_2, S_3 & S_4 are correct. **(D)** S_1,S_2 & S_3 are correct only.

108. Select the correct statement for the sulphuric acid.

(I) It has high boiling point and viscosity.

(II) There are two types of bond lengths in its bivalent anion.

(III) $p\pi$-$d\pi$ bonding between sulphur and oxygen is observed.

(IV) Sulphur has the same hybridisation that is of boron in diborane.

(A) II and III only **(B)** II, III and IV only
(C) I, III and IV only **(D)** III and IV only

109. Intermolecular hydrogen bonding increases the enthalpy of vaporization of a liquid due to the :

(A) decrease in the attraction between molecules.
(B) increase in the attraction between molecules.
(C) decrease in the molar mass of unassociated liquid molecules.
(D) increase in the effective molar mass of hydrogen - bonded molecules.

110. **S1 :** The polarising power of a cation and polarisability of an anion, both are directly proportional to their sizes.

S2 : H_2^+ and He_2^+ have same bond order but H_2^+ is more stable than He_2^+ .

S3 : The strength of hydrogen bond does not depend at all on the availability of the lone pair of electrons on the atom forming H-bond.

S4 : OF_2 and Cl_2O both are sp^3 hybridised and bond angle in Cl_2O is greater than 109º28'.

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

111. Which of the following has minimum melting point

(A) CsF **(B)** HCl **(C)** HF **(D)** LiF

112. Which of the following statemets is true?

(A) The dipole moment of NF_3 is zero **(B)** The dipole moment of NF_3 is less than NH_3
(C) The dipole moment of NF_3 is more than NH_3 **(D)** The dipole moment of NH_3 is zero

113. Among the following compounds, the correct order of the polarity of the bonds is :

$$SbH_3 , AsH_3 , PH_3 , NH_3 .$$

(A) $SbH_3 < AsH_3 < PH_3 < NH_3$ **(B)** $AsH_3 < SbH_3 = PH_3 < NH_3$
(C) $PH_3 < AsH_3 < SbH_3 < NH_3$ **(D)** $AsH_3 < PH_3 < SbH_3 < NH_3$

114. Among the following, van der Waals forces are maximum in :

(A) HBr **(B)** LiBr **(C)** LiCl **(D)** AgBr

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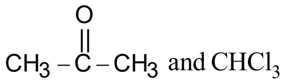
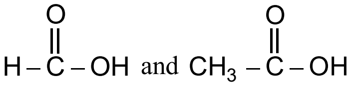
115. Intermolecular hydrogen bond is present in which of the following pair of molecules ?

(A) SiH_4 and SiF_4

(B) 
$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$ and $CHCl_3$

(C) 
$H-\overset{\overset{\displaystyle O}{\|}}{C}-OH$ and $CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-OH$

(D) CH_3OCH_3 and H_2O_2

116. Among the following compounds the one that is polar and has central atom with sp^3 hybridisation is :

(A) H_2CO_3 **(B)** SiF_4 **(C)** BF_3 **(D)** $HClO_2$

117. Which of the following are polar

(A) XeF_4 **(B)** SO_3 **(C)** $XeOF_4$ **(D)** ICl_4^-

118. Which of the following exhibits H-bonding ?

(A) CH_4 **(B)** H_2Se **(C)** N_2H_4 **(D)** H_2S

119. Bicarbonate (HCO_3^-) exists in $KHCO_3$ and $NaHCO_3$ respectively as :

(A) Dimeric and polymeric chain like structure.
(B) Polymeric chain and dimeric structure.
(C) Dimeric and trimeric structure.
(D) Trimeric and dimeric structure.

120. Covalent compounds have low melting point because

(A) Covalent bond is less exothermic
(B) Covalent molecules have definite shape
(C) Covalent bond is weaker than ionic bond
(D) Covalent molecules are held by weak Vander Waal's force of attraction

121. The bond that determines the secondary structure of a protein is

(A) Coordinate bond **(B)** Covalent bond **(C)** Hydrogen bond **(D)** Ionic bond

122. Pure phosphoric acid is very viscous, because :

(A) It is a strong acid
(B) It is tribasic acid
(C) It is hygroscopic
(D) It has PO_4^{3-} groups which are bonded by many hydrogen bonds

123. Which of the following is least volatile ?

(A) HF **(B)** HCl **(C)** HBr **(D)** HI

124. Which of the following is false ?

(A) Van der Waals forces are responsible for the formation of molecular crystals.
(B) Branching lowers the boiling points of isomeric organic compounds due to reduction in the van der Waals force of attraction.
(C) In graphite, van der Waals forces act between the carbon layers.
(D) Boiling point of NH_3 is greater than SbH_3.

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125. $SnCl_2.2H_2O$ readily loses one molecule of water at 80^0 C because :

(A) One water molecule is coordinated to lone pair of electrons on $SnCl_2$ and the other is hydrogen bonded to coordinated water molecule.

(B) One water molecule is bonded to $SnCl_2$ by coordinate covalent bond and the other is held by ion-dipole attractive forces to central metal ion.

(C) Both the water molecules are coordinated to lone pairs of electrons on pyramidal $SnCl_2$.

(D) Both the water molecules are bonded to pyramidal $SnCl_2$ by hydrogen bonds.

126. The pairs of bases in DNA are held together by

(A) Hydrogen bonds
(B) Ionic bonds
(C) Phosphate groups
(D) Deoxyribose groups

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Part # II [Assertion & Reason Type Questions]

Each question has 5 choices (A), (B), (C), (D) and (E) out of which only one is correct.

(A) Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation for Statement-1

(B) Statement-1 is true, Statement-2 is true and Statement-2 is not correct explanation for Statement-1

(C) Statement-1 is true, Statement-2 is false

(D) Statement-1 is false, Statement-2 is true

(E) Both Statements are false

1. **Statement-1 :** The bond angles of BrNO , CINO and FNO are approximately 114.5^0 , 113.3^0 and 110.1^0 respectively.
Statement-2 : The hybridisation of central N atom in all three compounds is sp^2.

2. **Statement-1 :** All F-S-F angles in SF_4 are greater than 90° but less than 180°.
Statement-2 : The bond pair-bond pair repulsion is weaker than lone pair-bond pair repulsion.

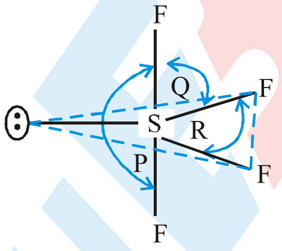
3. **Statement-1 :** In tetrahedral hybridisation i.e., in sp^3 hybridisation all p–orbitals of valence shell are involved and no p–orbital is left for forming π–bonds.
Statement-2 : Central atom can not form double bonds in the molecules or species having sp^3 hybridisation.

4. **Statement-1 :** Molecular species like SF_6, PF_5 , I_3^- and XeF_2 violate the octet rule.
Statement-2 : Compounds with an expanded octet are called hypervalent compounds.

5. **Statement-1 :** $[SiCl_6]^{2-}$ does not exist.
Statement-2 : Interaction between lone pairs of chloride ions and Si^{4+} is not very strong and six large chloride ions can not be accommodated around Si^{4+} due to limitation of its size.

6. **Statement-1 :** In CH_3NCO , the bond angles C – N – C and N – C – O are not identical.
Statement-2 : N–atom has a lone pair of electrons which is involved in $p\pi$-$d\pi$ delocalisation where as C–atom does not have lone pair of electrons.

7. **Statement-1 :**



Bond angle R is a normal triangular angle 120^0.

Statement-2 : $\angle P \neq 180^0$; $\angle Q \neq 90^0$ and thus $\angle R \neq 120^0$ but less then 120^0 due to the presence of a lone pair.

8. **Statement-1 :** In IOF_4^- a single lone pair is present on iodine atom trans to oxygen atom to have minimum repulsion between the I = O and the lone pair of electrons.
Statement-2 : The VSEPR model considers double and triple bonds to have slightly greater repulsive effect than single bonds because of the repulsive effect of π electrons.

9. **Statement-1 :** Molecules having different hybridisation can have same shape.
Statement-2 : The shape of a molecule does not depend on the hybridisation but it depends on the energy factor.

10. **Statement-1 :** SO_2 , NO_3^- and CO_3^{2-} are isoelectronic as well as isostructural species.
Statement-2 : The d and f–orbitals do not shield the nuclear charge very effectively. Therefore , there is significant reduction in the size of the ions , just after d or f orbitals have been completely filled.

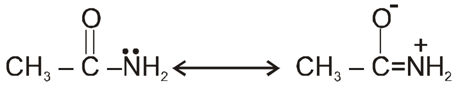
11. **Statement-1 :** NO_3^- and PO_3^- have similar formula type but differ structurally i.e. they have different type of hybridisation.
Statement-2 : NO_3^- ion exists as free ion. On the other hand PO_3^- exists as cyclic or linear polymeric structure.

12. **Statement-1 :** Carbon has unique ability to form pπ–pπ multiple bonds with itself and with other atoms of small size and high electronegativity.
Statement-2 : Heavier elements of group 14th do not form pπ–pπ bonds because their atomic orbitals are too large and diffuse to have effective side ways overlapping.

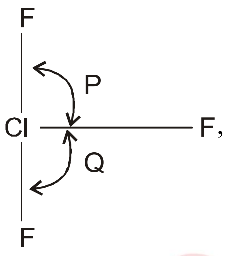
13. **Statement-1 :** Elemental nitrogen exists as a diatomic molecule and phosphorous as tetratomic molecule.
Statement-2 : Nitrogen does not have vacant d–orbital whereas phosphorus have vacant d–orbital.

14. **Statement-1 :** Single N–N bond is weaker than the single P–P bond.
Statement-2 : In N–N bond there is high interelectronic repulsion of the non–bonding electrons, owing to the weaker bond.

15. **Statement-1 :** The hybridisation of N atom in acetamide is sp^3.
Statement-2 : There occurs delocalisation of lone pair of electrons present on N atom.

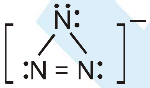


$$CH_3-\overset{\overset{O}{\|}}{C}-\ddot{N}H_2 \longleftrightarrow CH_3-\overset{\overset{O^-}{|}}{C}=\overset{+}{N}H_2$$

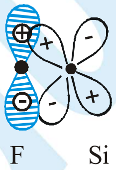
16. **Statement-1 :**  , bond angle P is equal to the bond angle Q but not precisely equal to 90^0.

Statement-2 : The molecule is T -Shaped and there is repulsion between lone pairs of electrons

17. **Statement-1 :** The electronic structure of azide ion (N_3^-) is $\left[:\ddot{N} \leftarrow N \equiv N:\right]^-$.

Statement-2 :  is not a resonating structure of azide ion, because the position of atoms cannot be changed.

18. **Statement-1 :** Si – F , Si – Cl and Si – O bonds are stronger than the corresponding bonds with C.

Statement-2 :  pπ – dπ overlapping

19. **Statement-1 :** Aluminium chloride in acidified aqueous solution forms octahedral $[Al(H_2O)_6]^{3+}$ ion.
Statement-2 : In $[Al(H_2O)_6]^{3+}$ complex ion, the 3d orbitals of Al are involved and the hybridisation state of Al is sp^3d^2.

20. **Statement-1 :** In graphite, on increasing the temperature the conductivity decreases along the layers of carbon atoms.
Statement-2 : Graphite cleaves easily, because the force of attraction between the layers is weak van der Waal's force.

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21. **Statement-1 :** A molecule of buckminister fullerene exhibits aromatic character.

Statement-2 : All the carbon atoms undergo sp^2 hybridisation. Each carbon atom forms three sigma bonds with other three carbon atoms. The remaining electron at each carbon is delocalised in molecular orbitals.

22. **Statement-1 :** Amongst the oxo acids of halogens, HOCl , HOBr and HOI, the HOI is the most acidic acid.

Statement-2 : The conjugate base stability is $ClO^- > BrO^- > IO^-$

23. **Statement-1 :** PF_5 keeps trigonal bipyramidal structure in gas as well as in solid state.

Statement-2 : PCl_5 in gas and liquid state is covalent but in solid state it is ionic and exist as $[PCl_4]^+$ and $[PCl_6]^-$

24. **Statement-1 :** The double bond in C_2 molecule consists of both π-bonds.

Statement-2 : Four electrons are present in two π–bonding molecular orbitals in C_2.

25. **Statement-1 :** Anhydrous $AlCl_3$ is more soluble in diethyl ether than hydrous $AlCl_3$.

Statement-2 : Anhydrous $AlCl_3$ is electron deficient. The oxygen atom of ether donates a pair of electrons to vacant p–orbital on the Al atom forming a co-ordinate bond.

26. **Statement-1 :** Atomic orbitals are monocentric while molecular orbitals are polycentric.

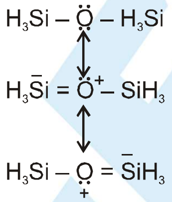
Statement-2 : In an atomic orbital the movement of an electron is influenced by only one positive nucleus, while that of an electron in a molecular orbital is influenced by two or more nuclei depending on the number of atoms contained in the molecule.

27. **Statement-1 :** To obtain effective pπ–dπ overlap , the size of the d–orbital must be similar to the size of the p–orbital. So for chlorine pπ–dπ bonding is strongest in their oxoanions.

Statement-2 : On moving a period from left to right in the periodic table , the nuclear charge is increased and more s and p-electrons are added. Since these s– and p–electrons shield the nuclear charge incompletely, the size of the atom and that of the d–orbitals decreases. This leads to progressively stronger pπ–dπ bonding.

28. **Statement-1 :** Dimethyl ether and disilyl ether both readily form complexes with trimethyl borane

Statement-2 :



29. **Statement-1 :** Solubility of LiI is more than that of LiBr.

Statement-1 : LiI has more lattice energy and more hydration energy in comparison to LiBr.

30. **Statement-1 :** Al^{3+} form more ionic compound in comparison to Ga^{3+}, with identical anion.

Statement-2 : $r_{Al^{3+}} \approx r_{Ga^{3+}}$ and Z_{eff} of Ga^{3+} is more than that of Al^{3+}.

31. **Statement-1 :** Ortho boric acid crystal are hard and cannot be broken easily into the powder form.

Statement-2 : In the solid state $B(OH)_3$ units are hydrogen bonded together into two dimensional sheets.

32. **Statement-1 :** The crystal structures of $NaHCO_3$ and $KHCO_3$, both show intermolecular hydrogen bonding but are different.

Statement-2 : In $NaHCO_3$ the HCO_3^- ions are linked together through intermolecular hydrogen bonds into an infinite chain , while in $KHCO_3$, HCO_3^- ions form dimeric anions through intermolecular hydrogen bonds.

33. **Statement-1 :** Fluorine (F_2) is gas while iodine (I_2) is solid at room temperature.
Statement-2 : A larger molecule or heavy atom is more polarizable and has larger dispersion forces because it has many electrons some of which are less tightly held and are farther from the nucleus.

34. **Statement-1 :** Noble gases are liquefied at very low temperature. Hence they have low boiling points.
Statement-2 : Noble gases being monoatomic have no other interatomic forces except weak dispersion forces.

35. **Statement-1 :** NF_3 has little tendency to act as a donor molecule.
Statement-2 : The highly electronegative F atoms attract electrons and these moments partly cancel the moment from the lone pair.

36. **Statement-1 :** Fluoromethane (CH_3F ; $\mu = 1.85$ D) has a smaller dipole moment than chloromethane (CH_3Cl ; $\mu = 1.87$ D)
Statement-2 : Fluorine has less electron affinity than that of chlorine.

37. **Statement-1 :** Acetylene is not soluble in H_2O but is highly soluble in acetone.
Statement-2 : Acetylene forms inter molecular H–bond with acetone easily but not with H_2O as water molecular themselves are highly associated through inter molecular H–bonds.

38. **Statement-1 :** Crystals of hydrated calcium sulphate (gypsum : ($CaSO_4 . 2 H_2O$)) are soft and easily cleaved.
Statement-2 : Crystals of anhydrous calcium sulphate (anhydride : $CaSO_4$) are very hard and very difficult to cleave.

39. **Statement-1 :** In case of persulphuric acid, the $K_1 >> K_2$.
Statement-2 : The anion of persulphuric acid is intermolecular hydrogen bonded.

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Exercise # 3 Part # I [Matrix Match Type Questions]

Match the compounds listed in column-I with characteristic(s) listed in column-II.

1.

Column-I	Column-II
(A) $IO_2F_2^-$	**(p)** sp^3d
(B) F_2SeO	**(q)** sp^3
(C) $ClOF_3$	**(r)** sp^2
(D) XeF_5^+	**(s)** sp^3d^2

2.

Column-I	Column-II
(A) SF_2	**(p)** sp^3 and bent
(B) KrF_4	**(q)** two lone pairs
(C) NOCl	**(r)** bond angle $< 109^0 28'$
(D) NF_3	**(s)** sp^2 and bent
	(t) sp^3d^2 and square planar

3.

Column – I	Column –II
(A) ClF_2^-, ClF_2^+	**(p)** Square pyramidal.
(B) $IO_2F_2^-$, F_2SeO	**(q)** See – saw and pyramidal shaped respectively.
(C) IOF_4^-, $XeOF_2$	**(r)** Linear and bent shaped respectively.
(D) BrF_5, $XeOF_4$	**(s)** Square pyramidal and T-shaped respectively.
	(t) Both sp^3d^2.

4.

Column (I)	Column (II)
(A) P_4	**(p)** 7 σ - bond
(B) SO_4^{2-}	**(q)** central atom is in sp^3 hybridisation
(C) C_2H_6	**(r)** No, 'P–P' bond
(D) P_4O_{10}	**(s)** No, 'O–O' bond

5.

Column-I	Column-II
(A) $H_3P_3O_9$	**(p)** S–O–S bond is present
(B) $H_2S_2O_7$	**(q)** Di-basic acid
(C) $H_2S_4O_6$	**(r)** P–O–P bond is present
(D) $H_4P_2O_5$	**(s)** Central atom (S or P) in maximum oxidation state.

6.

Column-I	Column-II
(A) N_2^+ is stable than N_2^-	**(p)** due to one have greater number of electrons in antibonding molecular orbitals than other
(B) NO can easily lose its electron than N_2	**(q)** one has B.O. 3 and other has 2.5
(C) NO have large bond length than NO^+	**(r)** both are paramagnetic with same bond order
(D) He_2^+ exists, but is less stable than H_2^+	**(s)** one is paramagnetic and other diamagnetic

7.

Column - I	Column - II
(A) BF_3	**(p)** sp^3 hybridization
(B) $(SiH_3)_3N$	**(q)** $p\pi - p\pi$ back bond
(C) B_2H_6	**(r)** $p\pi - d\pi$ back bond
(D) SiO_2	**(s)** 3c – 2e bond

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8.

Column – I	**Column – II**
(A) O_2 and NO^-	**(p)** Same magnetic property and bond order as that in N_2^+
(B) O_2^+ and NO	**(q)** Same bond order but not same magnetic property as that in O_2
(C) CO and CN^-	**(r)** Same magnetic property and bond order as that N_2^{2-}
(D) C_2 and CN^+	**(s)** Same magnetic property and bond order as that in NO^+

9.

Column – I	**Column – II**
(A) SO_3 (gas)	**(p)** Polar with pπ–dπ bonds and identical S–O bond, lengths.
(B) OSF_4	**(q)** One lone pair and pπ – dπ bond.
(C) SO_3F^-	**(r)** Non–polar with pπ – pπ and pπ – dπ bonds. Identical S–O bond lengths.
(D) $ClOF_3$	**(s)** Polar with pπ – dπ bond.

10.

Column – I	**Column – II**
(A) IF_2^-	**(p)** sp^3d
(B) ClF_3	**(q)** polar
(C) XeO_3F_2	**(r)** one of the bond angles is 180^0 .
(D) SF_4	**(s)** one lone pair

11.

Column-I	**Column-II**
(A) Blue vitriol	**(p)** Ionic bond
(B) Gypsum	**(q)** Covalent bond
(C) Pure orthophosphoric acid	**(r)** Hydrogen bond
(D) Chloral hydrate	**(s)** Resonance stabilisation

12.

Column-I	**Column-II**
(A) Liquid bromine	**(p)** Hydrogen bond
(B) Solid hydrogen fluoride	**(q)** Ion-dipole force
(C) Solution of sodium fluoride in water	**(r)** Dispersion force.
(D) Liquid methylamine	**(s)** Dipole induced dipole interaction.
(E) Noble gas clathrate.	

13.

Column-I	**Column-II**
(A) $HCl < HF$	**(p)** Strength of hydrogen bonding
(B) $PH_3 < NH_3$	**(q)** Dipole moment
(C) $H_2O < D_2O$	**(r)** Boiling point
(D) $F_2 < Cl_2$	**(s)** Bond energy

Part # II [Comprehension Type Questions]

Comprehension # 1

VSEPR Theory

The trigonal bipyramid is not a regular shape since the bond angles are not all the same. It therefore follows that the corners are not equivalent in ClF_3 molecule. Lone pairs occupy two of the corners, and F atoms occupy the other three corners. These different arrangements are theoretically possible, as shown in figure.

(i) The most stable structure will be the one of lowest energy, that is the one with the minimum repulsion between the five orbitals. The greatest repulsion occurs between two lone pairs. Lone pair bond pair repulsions are next strongest, and bond pair-bond pair repulsions the weakest.

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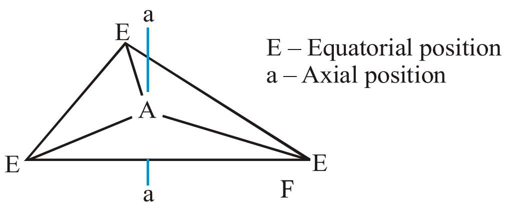
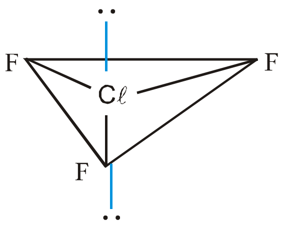
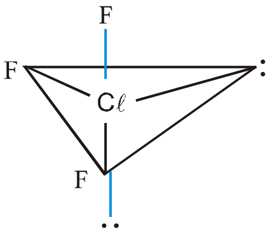
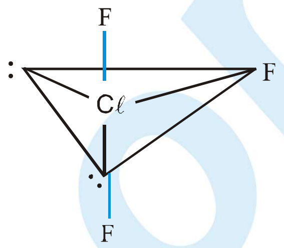




(1)



(2)



(3)

A rule of thumb can be theorised, that the position having maximum repulsion amongst them are occupied at equatorial points. Therefore (3) structure is right.

(ii) Since double bond occupies more space compared to single bond therefore it will prefer equatorial position.

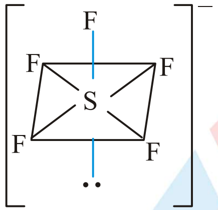
(iii) More electronegative element will occupy axial position in case of trigonal bipyramidal geometry

(iv) In case of sp^3d^2 hybridisation lone pairs should be placed opposite to each other because all the corners are identical.

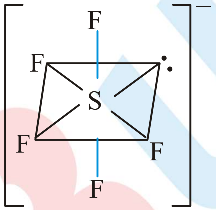
1. Geometry (i.e. arrangement of electron pairs around central atom) of $ClOF_3$ is similar to the :

(A) XeF_4 **(B)** $SOCl_2$ **(C)** I_3^- **(D)** ClO_4^-

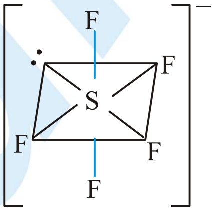
2. The shape of SF_5^- can be :



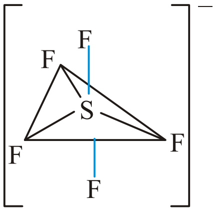
I



II



III



IV

(A) I only **(B)** I and II only **(C)** IV only **(D)** I, II, & III

3. Actual shape of the molecule BrF_5 is similar to the molecule :

(A) PCl_5 **(B)** XeF_4 **(C)** PCl_4^+ **(D)** None of these

4. Which of the following statements is/are correct for ClO_4^- oxoanion ?

(A) It does not have any tendency of polymerisation.

(B) It has strong pπ–pπ bonding between chlorine and oxygen.

(C) All Cl–O bonds are identical and chlorine atom is sp^3 hybridised.

(D) The chemical bonding takes place in ground state and charge dispersion is more than ClO_3^- oxo anion.

5. Which of the following do not exist ?

(A) SH_6 **(B)** HFO_4 **(C)** SI_6 **(D)** $HClO_3$

Comprehension # 2

The distribution of electrons among various molecular orbitals is called the electronic configuration of the molecule which provides us the following very important informations about the molecule .

(A) Stability of molecule : The molecule is stable if number of bonding molecular orbital electrons (N_b) is greater than the number of antibonding molecular orbital electrons (N_a) and vice- versa.

(B) Bond order :

Bond order = $\frac{1}{2}(N_b - N_a)$

A positive bond order means a stable molecule while a negative or zero bond order means an unstable molecule.

(C) Nature of the bond :

Bond order 1, 2,or 3 corresponds to single, double or triple bonds respectively.

(D) Bond length :

Bond length decreases as bond order increases.

(E) Magnetic nature :

Molecular orbitals in a molecule are doubly occupied, the substance is diamagnetic and if one or more molecular orbitals are singly occupied, it is paramagnetic.

1. 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 exit as the effect of bonding and anti-bonding molecular orbitals cancel each other

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

(D) In F_2 molecule, the energy of $\sigma 2P_z$ is more than π_{2px} and π_{2Py}

2. The bromine (Br_2) is coloured because:

(A) the difference in energy (ΔE) between HOMO and LUMO is large and the electronic excitation take place by absorption of light which falls in ultra violet region.

(B) the difference in energy (ΔE) between HOMO and LUMO is small and the electronic excitation take place by absorption of light which falls in infrared region.

(C) the bromine molecule is paramagnetic and the difference in energy (ΔE) is such that the electronic excitation take place in visible light.

(D) the difference in energy (ΔE) between HOMO and LUMO is such that the electronic excitation take place by absorption of light which falls in visible region and bromine molecule is diamagnetic.

3. N_2 has greater bond dissociation energy than N_2^+ , where as O_2 has a lower bond dissociation energy than O_2^+ because:

(A) Bond order is reduced when O_2 is ionized to O_2^+ and bond order is increased when N_2 is ionized to N_2^+

(B) Bond order is increased when O_2 is ionized to O_2^+ and bond order is decreased when N_2 is ionized to N_2^+

(C) Bond order is deceased when O_2 is ionized to O_2^+ and bond order is decreased when N_2^- is ionized to N_2^+

(D) None of these.

Comprehension # 3

A covalent bond in which electrons are shared unequally and the bonded atoms acquire a partial positive and negative charge, is called a polar covalent bond. Bond polarity is described in terms of ionic character.

Similarly in ionic bond, some covalent character is introduced because of the tendency of the cation to polarise the anion. The magnitude of covalent character in the ionic bond depends upon the extent of polarization caused by cations.

In general :

(i) Smaller the size of cation, larger is its polarizing power.

(ii) Larger the anion, more will be its polarisability.

(iii) Among two cations of similar size, the polarizing power of cations with pseudo - inert gas configuration ($ns^2np^6nd^{10}$) is larger than cation with noble gas configuration (ns^2np^6) e.g. polarizing power of Ag^+ is more than K^+.

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1. Which of the following will be most covalent ?

(A) NaCl **(B)** Na_2S **(C)** $MgCl_2$ **(D)** MgS

2. Which of the following is least ionic ?

(A) BeI_2 **(B)** $BeCl_2$ **(C)** $BeBr_2$ **(D)** BeF_2

3. Arrange the following compounds in increasing order of their ionic character :

$SnCl_2$, $SnCl_4$, $SiCl_4$, SnF_4, SnF_2

(A) $SnF_2 < SnCl_2 < SnF_4 < SnCl_4 < SiCl_4$

(B) $SnF_2 < SnCl_2 < SnF_4 < SiCl_4 < SnCl_4$

(C) $SiCl_4 < SnCl_4 < SnF_4 < SnCl_2 < SnF_2$

(D) $SnCl_4 < SnF_4 < SnCl_2 < SnF_2 < SiCl_4$

4. Which is the correct order of covalent character

(A) $BeF_2 < BeCl_2 < BeBr_2 < BeI_2$

(B) $BeCl_2 < BeF_2 < BeI_2 < BeBr_2$

(C) $BeI_2 < BeBr_2 < BeCl_2 < BeF_2$

(D) $BeI_2 < BeCl_2 < BeBr_2 < BeF_2$

5. Which of the following combination of cation and anion has maximum covalent character.

(A) K^+, Cl^- **(B)** Na^+, Cl^- **(C)** Cs^+, Cl^- **(D)** Mg^{+2}, Cl^-

Comprehension # 4

The degree of polarity of a covalent compound is measured by the dipole moment (μ_{bond}) of the bond defined as:

μ_{bond} = Charge on one of the poles × bond length

μ_{bond} is a vector quantity. The dipole moment of a molecule is the vector addition of all the bond dipole moments present in it. For a triatomic molecule, containing two bond's like H_2O, $\mu_{molecule}$ is given by

$$\mu^2_{molecule} = \mu^2_{bond} + \mu^2_{bond} + 2\mu_{bond} \cdot \mu_{bond} \cos\theta$$

θ = bond angle

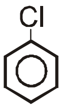
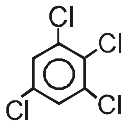
The % ionic character of a bond is calculated using the equations

$$\%\text{ ionic character} = \frac{\mu_{obs}}{\mu_{ionic}} \times 100$$

μ_{ionic} = dipole moment when the molecule is assumed to be completely ionic.

1. Which of the following molecule has non-zero dipole moment :

(A) XeF_2 **(B)** ClF_3 **(C)** XeO_2F_4 **(D)** XeF_4

2. The dipole moment of  is 1.5 D. The dipole moment of  will be -

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(A) 0 D **(B)** 1.5 D **(C)** 2.86 D **(D)** 2.25 D

3. Which of the following compound has Zero dipole moment -

(A) PCl_3 **(B)** PCl_2F_3 **(C)** PCl_3F_2 **(D)** $PClF_4$

Comprehension # 5

Molecular geometry is the general shape of a molecule as determined by the relative positions of the atomic nuclei. VSEPR model predicts the shape of the molecules & ions in which valence shell electron pairs are arranged about the atom as far away from one another as possible, thus minimizing pair repulsion information about the geometry of a molecule can sometimes be obtained from an experimental quantity called dipole moment.

1. The dipole moment of a triatomic molecule AX_2 was found to be equal to the bond moment of A – X bond. Which of the following information regarding geometry of the molecule can be drawn from the above observation.

(A) Molecule is linear

(B) Molecule is V shaped with $\angle X - A - X = 90°$

(C) Molecule is V shaped with $\angle X–A–X = 120°$

(D) Molecular geometry can not be predicted with the given information

2. Which of the following inter-halogen compounds is non-polar in nature:

(A) ClF_3 **(B)** BrF_5 **(C)** IF_7 **(D)** BrCl

Comprehension # 6

Nitrogen, oxygen and fluorine are the highly electronegative elements. When they are tied to a hydrogen atom to form covalent bond , the electrons of the covalent bond are shifted towards the more electronegative atom. This partially positively charged hydrogen atom forms a bond with the other electronegative atom. This bond is called as hydrogen bond and is weaker than covalent bond. For example, in HF molecule, the hydrogen bond exists between hydrogen atom of one molecule and fluorine atom of another molecule as depicted :$– – – H^{\delta+} – F^{\delta-} – – – H^{\delta+} – F^{\delta-} – – – H^{\delta+} – F^{\delta-}$

Here, hydrogen bond acts as a bridge between atoms which holds one atom by covalent bond and the other by hydrogen bond. Hydrogen bond is represented by a dotted line (– – –) while a solid line represents the covalent bond. Thus, hydrogen bond can be defined as the attractive force which binds hydrogen atom of one molecule with the electronegative atom (F, O or N) of another molecule.

1. What would be correct about bonding in chloral hydrate $CCl_3CH(OH)_2$?

(A) Only intra molecular H-bonding

(B) Only inter molecular H-bonding

(C) Both inter and intra molecular H-bonding

(D) No hydrogen bonding

2. If boiling point of ortho–nitro phenol and para nitro phenol are t_1 and t_2 respectively and mixture of these two are heated at temperature 't' where 't' is between these two temperature. Vapours will contains

(A) Only ortho nitro phenol

(B) Only para nitro phenol

(C) Both ortho and para nitro phenol

(D) None of these

3. What statement is **incorrect** about D_2O (solid)

(A) It will float in D_2O liquid

(B) It will sink in H_2O liquid

(C) It has maximum density at 4°C

(D) It has less volume than H_2O solid for same mass of both compound.

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Exercise # 4 [Subjective Type Questions]

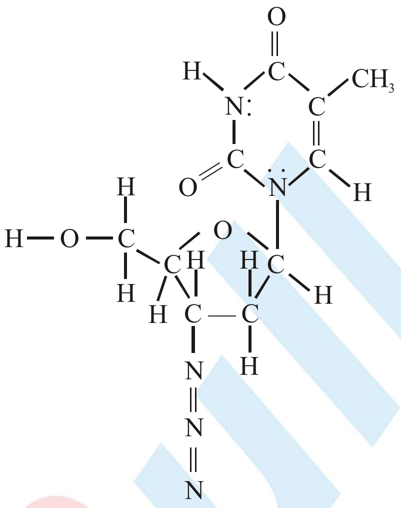
1. What type of bonding is expected between.
(a) a metal and a non-metal **(b)** two non-metal

2. Compare the bond angle in O_3 and SO_2.

3. Write down the resonating structures for SO_4^{2-} and NO_3^-.

4. Identify the type of overlapping in N–H bond in N_2H_4 molecule?

5. One of the first drugs to be prepared for use in treatment of acquired immuno deficiency syndrome (AIDS) was azidothymidine (AZT).



(a) How many carbon atoms have sp^3 hybridisation ?
(b) How many carbon atoms have sp^2 hybridisation ?
(c) How many nitrogen atoms (central atom not terminal) have sp hybridisation ?
(d) How many π bonds are in the molecule ?

6. Draw the structure of the following compounds. Clearly indicate the number of bond pairs and lone pairs involved on central atom. Write **(i)** number of bond pairs and lone pairs on the central atom **(ii)** the shape of the molecules **(iii)** hybridization of the central atom.
(a) SF_4 **(b)** $XeOF_4$

7. Assuming that all the four valency of carbon atom in propane pointing towards the corners of a regular tetrahedron. Calculate the distance between the terminal carbon atoms in propane. Given, C—C single bond length is 1.54 Å.

8. There will be three different flourine-flourine distances in molecule $F_2C{=}C{=}C{=}CF_2$. Assuming ideal bond angles for a particular hybridisation (assume no distortion due to double bonds), find out the two smaller flourine-flourine distances (in pm).

(Given that C–F bond length = 134 pm, C = C bond length = 134 pm, $\sqrt{3} = 1.7$)

9. Draw orbital overlap diagram for the cases given below. consider internuclear axis as y-axis . Also classify them as σ,π,δ if bond is formed by their overlap
(a) s and p_y **(b)** d_{xy} and p_y **(c)** s and p_z **(d)** p_x and p_x
(e) p_z and p_z **(f)** d_{xz} and d_{xz}

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10. SF_4 and SF_6 are known but OF_4 and OF_6 are not. Explain only in one or two lines.

11. Why electrovalent compounds do not show stereoisomerism?

12. The cynate ion $(OCN)^-$ form stable series of salts, but many fulminates $(CNO)^-$ are explosive. Explain.

13. BF_3 and graphite both are coplanar having sp^2 hybridisition yet graphite is a conductor. Explain.

14. Draw structures for the polymeric $(BeH_2)_n$ and $(BeCl_2)_n$. Explain in brief why the hydride bridge in $(BeH_2)_n$ is considered to be electron deficient but not the halide bridge in $(BeCl_2)_n$?

15. Find number of bonds in : **(a)** $P_3O_{10}^{5-}$ with bond order = $\frac{4}{3}$ **(b)** $S_2O_7^{2-}$ with bond order = $\frac{5}{3}$

16. The number of P–S bonds and P– P bonds in P_4S_3 are x and y respectively. The number of π–bonds in P_4O_{10} is z. Fill answer in bubbles as xyz.

17. Discuss the bond order and magnetic nature of following species.

$NO, NO^+ NO^{2+}, NO^-$

18. **(a)** Number of shared 'O' atoms in $[Si_6O_{18}]^{12-}$ cyclic silicate.

(b) Number of S – S bond present in $H_2S_4O_6$ (tetrathionic acid).

(c) Number of P – P bonds in P_4S_3 molecule.

(d) Maximum number of equivalent N – O bonds in N_2O_5 (g).

(e) Number of S – O – S bonds in cyclic trimer of SO_3.

19. Answer the following questions with respect to the compound $\underline{NO}[BF_4]$.

(P) Bond order of the part underlined.

(Q) Total number of σ bonds in the compound.

(R) Total number of π bonds in the compound.

(S) Number of hybrid orbitals involved in the hybridisation of boron.

P	Q	R	S

20. **(a)** Number of unpaired electrons in $O_2[AsF_6]$.

(b) Bond order of O – O bond in Na_2O_2

(c) Number of polar bonds in H_2O_2

(d) Number of π bonds in carbon suboxide molecule.

(e) Number of non bonded electron pairs is present in $N(SiMe_3)_3$.

Fill your answer in the box provides :

21. Answer the following questions about the structure of the dimer of phosphorus pentaoxide.

(i) The number of P – O linkages which have bond length equal to 1.43Å.

(ii) The number of covalent bonds which have bond length equal to 1.60Å.

(iii) The number of P – O – P linkages.

(iv) The number of lone pair(s) of electrons on each phosphorus atom.

(i)	(ii)	(iii)	(iv)

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22. Find number of 3c–2e bond in $(BeH_2)_n$

23. In trimethylamine, the nitrogen has a pyramidal geometry whereas in trisilylamine $N(SiH_3)_3$ it has a planar geometry. Explain? Out of trimethylamine and trisilyamine which one is more basic and why ?

24. O_2, N_2 are colourless gases but Cl_2, Br_2, I_2 are coloured gases. Explain on the basis of M.O. theory.

25. Draw the molecular orbital (both bonding and antibonding) and identify the number of nodal planes in the following combination of atomic orbitals with z as internuclear axis : d_{yz} and d_{yz}

26. Draw structure of boron nitride and express the hybridisation of B and N . Will it conduct electricity like graphite?

27. Arrange the following compounds in the order of increasing ionic character : KI, AlP, CaS, MgO.

28. The M.P. of NaCl is higher than that of $AlCl_3$. Explain.

29 Alkali metals impart colour to the flame. Explain.

30. Radii of the following cations are nearly same. Arrange them in the increasing order of polarising power :

(i) Mg^{2+}, Fe^{2+}, Ni^{2+}, Zn^{2+} **(ii)** Ga^{3+}, Fe^{3+}, Al^{3+}

31. Arrange the following in increasing order of melting points.

(i) XeF_2, XeF_4, XeF_6 **(ii)** $TiCl_2$, $TiCl_3$, $TiCl_4$ **(iii)** NaCl, $MgCl_2$, $AlCl_3$

32 Out of the given species, which one has highest polarising power and why.

Na^+, Ca^{2+}, Mg^{2+}, Al^{3+}

33. HF forms H-bonding with acetylene while it is a non polar molecule. Explain.

34. It is said that two –OH groups present on a carbon are unstable. But choral hydrate $CCl_3CH(OH)_2$ is fairly stable. Explain.

35. Thio - ethers have higher boiling point than ethers. Explain.

36. Two atoms A and B have electronegativities as 2.1 and 3.5. These two atoms are covalently single bonded and compound AB has experimental dipole moment equal to 1.4 D. Calculate AB bond length in Å(Use Hanny smith formula for calculation of percentage ionic character).

37. Dipole moment of LiF was experimentally determined and was found to be 6.0 D. Calculate percentage of ionic character in LiF molecule. LiF bond length is 2.5 Å.

38. The gaseous metallic chloride (MCl type) molecule has a measured dipole moment of 9.0 D, which indicates that it is a very polar molecule. The separation between the nuclei in this molecule is 2.25×10^{-8} cm. Calculate the percentage ionic character in KCl molecule. [1.6×10^{-19} , $C = 4.8 \times 10^{-10}$ esu]

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39. The bond angle in H_2S is 97° and its dipole moment is 1.5 D. The S – H bond distance is 0.15 nm. Therefore, approximate percentage ionic character of S – H bond is (neglect the effect of dipole moment of lone pair on sulphur atom in H_2S). (Given [$\cos 97° = -0.12$] and $\sqrt{0.88} = 0.94$)

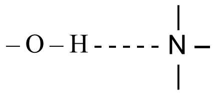
40. Arrange the following in the increasing order as stated below :

(i) Polarisibility (for the same cation) : O^{2-}, F^-, N^{3-}

(ii) Covalent character : LiI, LiBr, LiF

(iii) H-bond strength :

P :

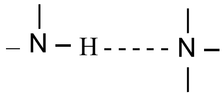


$-O-H\text{-----}\overset{|}{\underset{|}{N}}-$

Q :

$-\overset{|}{N}-H\text{-----}\overset{|}{O}-$

R :



$-\overset{|}{N}-H\text{-----}\overset{|}{\underset{|}{N}}-$

S :

$-O-H\text{-----}\overset{|}{O}-$

(iv) Boiling point : NH_3, AsH_3, PH_3

41. Which among the following will have zero dipole moment.

H_2O, CO_2, BF_3, NH_3

42. Out of the given bonds, which one is most polar?

(a) C–O **(b)** C–F **(c)** O–F **(d)** N–F

43. Answer the following questions :

(P) The number of pπ-dπ bonds in S_3O_9.

(Q) The bond order of the underlined species ; $\underline{NO}HSO_4$.

(R) The number of vacant hybrid orbitals which participate in the formation of 3-centre 2 electron bonds i.e., banana bonds in diborane structure.

(S) The number of intramolecular H-bonds formed in a molecule of chloral hydrate.

(P)	(Q)	(R)	(S)

44. The dipole moment of HBr is 2.60×10^{-30} Cm and the inter-atomic distance is 1.41 Å. What is the per cent ionic character of HBr ?

45. A diatomic molecule has a dipole moment of 1.2 D. If bond length is 1.0 Å, what percentage of an electronic charge exists on each atom.

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46. Arrange the following

(i) N_2, O_2, F_2, O^+_2; in increasing order of bond dissociation energy.

(ii) O, S, F, Cl, N; in increasing strength of hydrogen bonding (X – H – – – X).

(iii) N_3^-, BF_3, NH_3, XeF_4. in increasing bond angle.

47. The dipole moment of a molecule is really the vectorial sum of the individual bond moment present in it. To compute the dipole moment it is necessary to find out the values of various bond moment. in the following table dipole moment of different bonds are as given.

Bond	$\overset{\longrightarrow}{H - C}$	$\overset{\longrightarrow}{C - Cl}$	$\overset{\longrightarrow}{C = O}$
Bond moments	0.4 D	1.5 D	2.5 D

The group moments of few group as given

Group	NO_2	OH	CN	CH_3
direction of dipole	toward N	towards O	toward N	away from CH_3
Dipole moment	4D	1.6 D	3.8 D	0.4 D

(i) In CH_3CCl_3 (I), $CHCl_3$ (II) and CH_3Cl (III) the normal tetrahedral bond angle is maintained. Also given

$\cos 70.5° = \frac{1}{3}$. Find dipole moments of the given compounds. (given due to – I effect of Cl, the Bond moment of H—C bond directed toward the H in $CHCl_3$)

(ii) In the acetone molecule considering the normal planer structure, find the observed dipole moment of acetone molecule.

48. Explain the H-bonding in crystalline $NaHCO_3$ and $KHCO_3$?

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Exercise # 5 Part # I [Previous Year Questions] [AIEEE/JEE-MAIN]

1. The correct order of bond angles (smallest first) in H_2S, NH_3, BF_3 and SiH_4 is :– **[AIEEE–2004]**

(1) $H_2S < NH_3 < SiH_4 < BF_3$
(2) $NH_3 < H_2S < SiH_4 < BF_3$
(3) $H_2S < SiH_4 < NH_3 < BF_3$
(4) $H_2S < NH_3 < BF_3 < SiH_4$

2. The bond order in NO is 2.5 while that in NO^+ is 3. Which of the following statements is true for these two species ? **[AIEEE–2004]**

(1) Bond length in NO^+ is equal to that in NO
(2) Bond length in NO is greater than in NO^+
(3) Bond length in NO^+ is greater than in NO
(4) Bond length is unpredictable

3. The states of hybridization of boron and oxygen atoms in boric acid (H_3BO_3) are respectively **[AIEEE–2004]**

(1) sp^3 and sp^2
(2) sp^2 and sp^3
(3) sp^2 and sp^2
(4) sp^3 and sp^3

4. Which one of the following has the regular tetrahedral structure ? **[AIEEE–2004]**

(1) BF_4^-
(2) SF_4
(3) XeF_4
(4) $[Ni(CN)_4]^{2-}$

(Atomic nos.: B = 5, S = 16, Ni = 28, Xe = 54)

5. The maximum number of 90° angles between bond pair-bond pair of electrons is observed in :- **[AIEEE–2004]**

(1) dsp^2 hybridization
(2) sp^3d hybridization
(3) dsp^3 hybridization
(4) sp^3d^2 hybridization

6. Beryllium and aluminium exhibit many properties which are similar. But, the two elements differ in **[AIEEE–2004]**

(1) Forming covalent halides
(2) Forming polymeric hydrides
(3) Exhibiting maximum covalency in compounds
(4) Exhibiting amphoteric nature in their oxides

7. Which one of the following species is diamagnetic in nature ? **[AIEEE-2005]**

(1) He_2^+
(2) H_2
(3) H_2^+
(4) H_2^-

8. lattice energy of an ionic compound depends upon **[AIEEE-2005]**

(1) charge on the ion only
(2) size of the ion only
(3) packing of the ion only
(4) charge and size of the ion

9. The molecular shapes of SF_4, CF_4 and XeF_4 are **[AIEEE-2005]**

(1) the same with 2, 0 and 1 lone pair of electrons on the central atom, respecitvely
(2) the same with 1, 1 and 1 lone pair of electrons on the central atoms, respectively
(3) different with 0, 1 and 2 lone pair of electrons on the central atoms, respectively
(4) different with 1, 0 and 2 lone pair of electrons on the central atoms, respectively

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10. Of the following sets which one does not contain isoelectronic species ? **[AIEEE-2005]**

(1) $PO_4^{3-}, SO_4^{2-}, ClO_4^-$
(2) CN^-, N_2, C_2^{2-}
(3) $SO_3^{2-}, CO_3^{2-}, NO_3^-$
(4) $BO_3^{3-}, CO_3^{2-}, NO_3^-$

11. Which of the following molecules\ions does not contain unpaired electrons? **[AIEEE-2006]**

(1) N_2^+
(2) O_2
(3) O_2^{2-}
(4) B_2

12. Among the following mixtures, dipole-dipole as the major interaction, is present in **[AIEEE-2006]**

(1) KCl and water
(2) benzene and carbon tetrachloride
(3) benzene and ethanol
(4) acetonitrile and acetone

13. A metal, M forms chlorides in its +2 and +4 oxidation states. Which of the following statements about these chlorides is correct? **[AIEEE-2006]**

(1) MCl_2 is more ionic than MCl_4
(2) MCl_2 is more easily hydrolysed than MCl_4
(3) MCl_2 is more volatile than MCl_4
(4) MCl_2 is more soluble in anhydrous ethanol than MCl_4

14. In which of the following molecules/ions are all the bonds **not** equal? **[AIEEE-2006]**

(1) XeF_4
(2) BF_4^-
(3) SF_4
(4) SiF_4

15. The decreasing values of bond angles from NH_3 (106°) to SbH_3 (91°) down group-15 of the periodic table is due to **[AIEEE-2006]**

(1) decreasing lp – bp repulsion
(2) increasing electronegativity
(3) increasing bp – bp repulsion
(4) increasing p-orbital character in sp^3

16. In which of the following ionizion processes, the bond order has increased and the magnetic behaviour has changed **[AIEEE-2007]**

(1) $NO \rightarrow NO^+$
(2) $O_2 \rightarrow O_2^+$
(3) $N_2 \rightarrow N_2^+$
(4) $C_2 \rightarrow C_2^+$

17. Which of the following hydrogen bonds is the strongest **[AIEEE-2007]**

(1) F–H.....F
(2) O–H.....O
(3) O–H.....F
(4) O–H.....N

18. Which of the following species exhibits the diamagnetic behaviour **[AIEEE-2007]**

(1) O_2^+
(2) O_2
(3) NO
(4) O_2^{2-}

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19. The charge/size ratio of a cation determines its polarizing power. Which one of the following sequences represents the increasing order of the polarizing power of the cationic species, K^+, Ca^{+2}, Mg^{+2}, Be^{+2} **[AIEEE-2007]**

(1) $Be^{+2} < K^+ < Ca^{+2} < Mg^{+2}$
(2) $K^+ < Ca^{+2} < Mg^{+2} < Be^{+2}$
(3) $Ca^{+2} < Mg^{+2} < Be^{+2} < K^+$
(4) $Mg^{+2} < Be^{+2} < K^+ < Ca^{+2}$

20. Using MO theory predict which of the following species has the shortest bond length? **[AIEEE-2009]**

(1) O_2^- **(2)** O_2^{2-} **(3)** O_2^{2+} **(4)** O_2^+

21. The hybridisation of orbitals of N atom in NO_3^-, NO_2^+ and NH_4^+ are respectively:- **[AIEEE-2011]**

(1) sp, sp^3, sp^2 **(2)** sp^2, sp^3, sp **(3)** sp, sp^2, sp^3 **(4)** sp^2, sp, sp^3

22. The structure of IF_7 is :- **[AIEEE-2011]**

(1) octahedral
(2) pentagonal bipyramid
(3) square pyramid
(4) trigonal bipyramid

23. Among the following the maximum covalent character is shown by the compound :- **[AIEEE-2011]**

(1) $AlCl_3$ **(2)** $MgCl_2$ **(3)** $FeCl_2$ **(4)** $SnCl_2$

24. Which of the following has maximum number of lone pairs associated with Xe ? **[AIEEE-2011]**

(1) XeO_3 **(2)** XeF_4 **(3)** XeF_6 **(4)** XeF_2

25. The number of types of bonds between two carbon atoms in calcium carbide is :- **[AIEEE-2005, 2011]**

(1) One sigma, two pi **(2)** One sigma, one pi **(3)** Two sigma, one pi **(4)** Two sigma, two pi

26. Ortho-Nitrophenol is less soluble in water than p– and m– Nitrophenols because :- **[AIEEE-2005, 2012]**

(1) Melting point of o–Nitrophenol is lower than those of m– and p– isomers
(2) o–Nitrophenol is more volatile in steam than those of m– and p– isomers
(3) o–Nitrophenol shows Intramolecular H–bonding
(4) o–Nitrophenol shows Intermolecular H–bonding

27. Iron exhibits +2 and +3 oxidation states. Which of the following statements about iron is **incorrect** **[AIEEE-2012]**

(1) Ferrous compounds are more easily hydrolysed than the corresponding ferric compounds.
(2) Ferrous oxide is more basic in nature than the ferric oxide.
(3) Ferrous compounds are relatively more ionic than the corresponding ferric compounds.
(4) Ferrous compounds are less volatile than the corresponding ferric compounds.

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28. The molecule having smallest bond angle is :- **[AIEEE-2012]**

(1) PCl_3 **(2)** NCl_3 **(3)** $AsCl_3$ **(4)** $SbCl_3$

29. In which of the following pairs the two species are not isostructural ? **[AIEEE-2012]**

(1) AlF_6^{3-} and SF_6 **(2)** CO_3^{2-} and NO_3^- **(3)** PCl_4^+ and $SiCl_4$ **(4)** PF_5 and BrF_5

30. Which one of the following properties is **not** shown by NO? **[JEE MAIN-2014]**

(1) It combines with oxygen to form nitrogen dioxide

(2) It's bons oeswe ia 2.5

(3) It is diamagnetic in gaseous state

(4) It is a neutral oxide

31. Among the following oxoacids, the correct decreasing order of acid strength is : **[JEE MAIN-2014]**

(1) $HClO_4 > HClO_3 > HClO_2 > HOCl$ **(2)** $HClO_2 > HClO_4 > HClO_3 > HOCl$

(3) $HOCl > HClO_2 > HClO_3 > HClO_4$ **(4)** $HClO_4 > HOCl > HClO_2 > HClO_3$

32. Which among the following is the most reactive ? **[JEE MAIN-2015]**

(1) I_2 **(2)** ICl **(3)** Cl_2 **(4)** Br_2

33. Which one has the highest boiling point? **[JEE MAIN-2015]**

(1) Kr **(2)** Xe **(3)** He **(4)** Ne

34. The species in which the N atom is in a state of sp hybridization is: **[JEE MAIN-2016]**

(1) NO_2^- **(2)** NO_3^- **(3)** NO_2 **(4)** NO_2^+

35. The pair in which phosphorous atoms have a formal oxidation state of +3 is : **[JEE MAIN-2016]**

(1) Pyrophosphorous and hypophosphoric acids

(2) Orthophosphorous and hypophosphoric acids

(3) Pyrophosphorous and pyrophosphoric acids

(4) Orthophosphorous and pyrophosphorous acids

36. The reaction of zinc with dilute and concentrated nitric acid, respectively, produces: **[JEE MAIN-2016]**

(1) NO_2 and NO **(2)** NO and N_2O **(3)** NO_2 and N_2O **(4)** N_2O and NO_2

37. Which of the following compounds is metallic and ferromagnetic ? **[JEE MAIN-2016]**

(1) CrO_2 **(2)** VO_2 **(3)** MnO_2 **(4)** TiO_2

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38. The species in which the N atom is in a state of sp hybridization is: **[JEE MAIN-2016]**

(1) NO_2^- **(2)** NO_3^- **(3)** NO_2 **(4)** NO_2^+

39. Which of the following species in not paramagnetic ? **[JEE MAIN-2017]**

(1) NO **(2)** CO **(3)** O_2 **(4)** B_2

40. The group having isoelectronic species is : **[JEE MAIN-2017]**

(1) O^{2-}, F^-, Na^+, Mg^{2+} **(2)** O^-, F^-, Na, Mg^+ **(3)** O^{2-}, F^-, Na, Mg^{2+} **(4)** O^-, F^-, Na^+, Mg^{2+}

41. Total number of lone pair of electrons in I_3^- ion is : **[JEE MAIN-2018]**

(1) 6 **(2)** 9 **(3)** 12 **(4)** 3

42. According to molecular orbital theory, which of the following will not be a viable molecule ? **[JEE MAIN-2018]**

(1) He_2^+ **(2)** H_2^- **(3)** H_2^{2-} **(4)** He_2^{2+}

Part # II [Previous Year Questions][IIT-JEE ADVANCED]

1. According to molecular orbital theory which of the following statement about the magnetic character and bond order is correct regarding O_2^+ **[JEE 2004]**

(A) Paramagnetic and Bond order < O_2 **(B)** Paramagnetic and Bond order > O_2

(C) Diamagnetic and Bond order < O_2 **(D)** Diamagnetic and Bond order > O_2

2. Which species has the maximum number of lone pair of electrons on the central atom?

(A) ClO_3^- **(B)** XeF_4 **(C)** SF_4 **(D)** I_3^- **[JEE 2005]**

3. The percentage of p-character in the orbitals forming P–P bonds in P_4 is

(A) 25 **(B)** 33 **(C)** 50 **(D)** 75

4. Among the following, the paramagnetic compound is **[JEE 2007]**

(A) Na_2O_2 **(B)** O_3 **(C)** N_2O **(D)** KO_2

5. The species having bond order different from that in CO is **[JEE 2007]**

(A) NO^- **(B)** NO^+ **(C)** CN^- **(D)** N_2

6. The structure of XeO_3 is **[JEE 2007]**

(A) linear **(B)** planar **(C)** pyramidal **(D)** T-shaped

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7. **Statement-1 :** p-Hydroxybenzoic acid has a lower boiling point than o-hydroxybenzoic acid. **[JEE 2007]**

Statement-2 : o-Hydroxybenzoic acid has intramolecular hydrogen bonding.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(C) Statement-1 is True, Statement-2 is False.

(D) Statement-1 is False, Statement-2 is True.

8. **Statement-1 :** In water, orthoboric acid behaves as a weak monobasic acid. **[JEE 2007]**

Statement-2 : In water, orthoboric, acid acts as a proton donor.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(C) Statement-1 is True, Statement-2 is False.

(D) Statement-1 is False, Statement-2 is True.

9. **Statement-1 :** Pb^{+4} compounds are stronger oxidizing agents than Sn^{4+} compounds **[JEE 2008]**

Statement-2 : The higher oxidation states for the group 14 elements are more stable for the heavier members of the group due to 'inert pair effect' .

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(C) Statement-1 is True, Statement-2 is False.

(D) Statement-1 is False, Statement-2 is True.

10. Match each of the diatomic molecules in Column I with its property / properties in Column II. **[JEE 2009]**

Column I		**Column II**	
(A)	B_2	**(P)**	Paramagnetic
(B)	N_2	**(Q)**	undergoes oxidation
(C)	O_2^-	**(R)**	Undergoes reduction
(D)	O_2	**(S)**	Bond order ≤ 2
		(T)	Mixing of 's' and `p' orbitals

11. The nitrogen oxide(s) that contain(s) N–N bond(s) is (are) **[JEE 2009]**

(A) N_2O **(B)** N_2O_3 **(C)** N_2O_4 **(D)** N_2O_5

12. In the reaction **[JEE 2009]**

$$2X + B_2H_6 \longrightarrow [BH_2(X)_2]^+ [BH_4]^-$$

the amine(s) X is (are)

(A) NH_3 **(B)** CH_3NH_2 **(C)** $(CH_3)_2NH$ **(D)** $(CH_3)_3N$

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13. The species having pyramidal shape is **[JEE 2010]**

(A) SO_3 **(B)** BrF_3 **(C)** SiO_3^{2-} **(D)** OSF_2

14. Assuming that Hund's rule is violated, the bond order and magnetic nature of the diatomic molecule B_2 is **[JEE 2010]**

(A) 1 and diamagnetic **(B)** 0 and diamagnetic **(C)** 1 and paramagnetic **(D)** 0 and paramagnetic

15. In allene (C_3H_4), the type(s) of hybridisation of the carbon atoms is (are) **[JEE 2012]**

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

(C) only sp^2 **(D)** sp^2 and sp^3

16. Which ordering of compounds is according to the decreasing order of the oxidation state of nitrogen- **[JEE 2012]**

(A) HNO_3, NO, NH_4Cl, N_2 **(B)** HNO_3, NO, N_2, NH_4Cl

(C) HNO_3, NH_4Cl, NO, N_2 **(D)** NO, HNO_3, NH_4Cl, N_2

17. The shape of XeO_2F_2 molecule is : **[JEE 2012]**

(A) Trigonal bipyramidal **(B)** Square planar **(C)** tetrahedral **(D)** see-saw

18. The pair(s) of reagents that yield paramagnetic species is/are **[JEE '14]**

(A) Na and excess of of NH_3 **(B)** K and excess of O_2

(C) Cu and dilute HNO_3 **(D)** O_2 and 2-ethylanthraquinol

19. The correct statement(s) for orthoboric acid is/are **[JEE '14]**

(A) It behaves as a weak acid in water due to self ionization.

(B) Acidity of its aqueous solutoin increases upon addition of ethylene glycol.

(C) It has a three dimensional structure due to hydrogen bonding.

(D) It is weak electrolyte in water

20. Assuming 2s-2p mixing is **NOT** operative, the paramagnetic species among the following is : **[JEE '14]**

(A) Be_2 **(B)** B_2 **(C)** C_2 **(D)** N_2

21. The total number of lone pairs of electrons in N_2O_3 is. **[JEE '15]**

22. Among the triatomic molecules/ions, $BeCl_2$, N_3^-, N_2O, NO_2^+, O_3, SCl_2, ICl_2^-, I_3^-, and XeF_2, the total number of linear molecule(s)/ion(s) where the hybridization of the central atom does not have contribution from the d-orbital(s) is

[Atomic number: S = 16, Cl = 17, I = 53 and Xe = 54] **[JEE '15]**

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23. The correct statement(s) regarding, (i) HClO, (ii) $HClO_2$, (iii) $HClO_3$ and (iv) $HClO_4$ is (are) **[JEE '15]**

(A) The number of Cl = O bonds in (ii) and (iii) together is two

(B) The number of lone pairs of electrons on Cl in (ii) and (iii) together is three

(C) The hybridization of Cl in (iv) is sp^3

(D) Amongst (i) to (iv), the strongest scid is (i)

24. Under hydrolytic conditions, the compounds used for preparation of linear polymer and for chain termination, respectively, are **[JEE '15]**

(A) CH_3SiCl_3 and $Si(CH_3)_4$ **(B)** $(CH_3)_2SiCl_2$ and $(CH_3)_3SiCl$

(C) $(CH_3)_2SiCl_2$ and CH_3SiCl_3 **(D)** $SiCl_4$ and $(CH_3)_3SiCl$

25. The compound(s) with TWO lone pairs of electrons on the central atom is(are) **[JEE '16]**

(A) BrF_5 **(B)** ClF_3 **(C)** XeF_4 **(D)** SF_4

26. According to Molecular Orbital Theory, **[JEE '16]**

(A) C_2^{2-} is expected to be diamagnetic

(B) O_2^{2+} is expected to have a longer bond length than O_2

(C) N_2^+ and N_2^- have the same bond order

(D) He_2^+ has the same energy as two isolated He atoms

Subjective

27. Decreasing order of the O-O bond length present in them **[JEE 2004]**

O_2, KO_2 and O_2 $[AsF_4]$

28. The number of water molecule(s) directly bonded to the metal centre in $CuSO_4.5H_2O$ is **[JEE 2009]**

29. Based on VSEPR theory, the number of 90 degree F–Br–F angles in BrF_5 is **[JEE 2010]**

30. The value of n in the molecular formula $Be_nAl_2Si_6O_{18}$ is **[JEE 2010]**

31. The total number of diprotic acids among the following is **[JEE 2010]**

H_3PO_4 H_2SO_4 H_3PO_3 H_2CO_3 $H_2S_2O_7$

H_3BO_3 H_3PO_2 H $_2CrO_4$ H_2SO_3

32. Among the following, the number of elements showing only one non-zero oxidation state is **[JEE 2010]**

O, Cl, F, N, P, Sn, Tl, Na, Ti

33. The difference in the oxidation numbers of the two types of sulphur atoms in $Na_2S_4O_6$ is. **[JEE 2011]**

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34. The sum of the number of lone pairs of electrons on each central atom in the following species is – **[JEE '17]**

$[TeBr_6]^{2-}$, $[BrF_2]^+$, SNF_3, and $[XeF_3]^-$

(Atomic numbers : N = 7, F = 9, S = 16, Br = 35, Te = 52, Xe = 54)

35. Among H_2, He_2^+, Li_2, Be_2, B_2, C_2, N_2, O_2^- and F_2, the number of diamagnetic species is **[JEE '17]**
(Atomic numbers : H = 1, He = 2, Li = 3, Be = 4, B = 5, C = 6, N = 7, O = 8, F = 9)

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MOCK TEST

SECTION - I : STRAIGHT OBJECTIVE TYPE

1. Select the most ionic and most covalent compounds respectively from the following.

CrO_5, Mn_2O_7, PbO, P_4O_{10}, SnO_2

(A) CrO_5, Mn_2O_7 **(B)** Mn_2O_7, PbO **(C)** CrO_5, P_4O_{10} **(D)** CrO_5, SnO_2

2. In which of the following sets central atom of each member involves sp^3 hybridisation ?

(A) IO_4^-, ICl_4^-, IF_4^+ **(B)** XeO_3, XeO_4, XeF_4

(B) SO_3, SO_3^{2-}, SO_4^{2-} **(D)** PCl_4^+, BF_4^-, ClO_4^-

3. What is wrong about P_4O_{10} molecule?

(A) POP angle is 180°

(B) Each 'P' atom can be considerd to be sp^3 hybridised

(C) There are two types of P–O bond lengths

(D) There are 6 P–O–P bonds.

4. Which of the following statement is true for $IO_2F_2^-$ according to VSEPR theory?

(A) The lone pair and two I– O double bonds occupy the equatorial positions of trigonal bipyramid.

(B) It has sp3d hybridisation and is T-shaped.

(C) Its structure is analogous to SF_4.

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

5. In the equation ;

$$A + 2B + H_2O \longrightarrow C + 2D$$

where $A = HNO_2$; $B = H_2SO_3$; $C = NH_2OH$

Identify the geometry and hybridisation of (D)

(A) Trigonal planar and sp^2 **(B)** Bent and sp^2

(C) Tetrahedral and sp **(D)** Trigonal pyramidal and sp^3.

6. The structure of F_2SeO is analogous to :

(A) SO_3 **(B)** ClO_3^- **(C)** SO_3^{2-} **(D)** Both (B) and (C)

7. A diatomic molecule has a dipole moment of 1.2 D. If its bond length is equal to 10^{-10} m then the fraction of an electronic charge on each atom will be :

(A) 42% **(B)** 52% **(C)** 37% **(D)** 25%

8. Which of the following statement is correct?

(A) $(SiH_3)_3N$ is a weaker Lewis base than $(CH_3)_3SiOH$.

(B) Like CO, its analogue of Si is not stable

(C) In phosgene, C–O bond length is longer than expected while C–Cl bond length is shorter.

(D) All of these

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9. Which reactions involve a change in the electron-pair gemoetry for the under lined geometry ?

(A) $\underline{B}F_3 + F^- \longrightarrow \underline{B}F_4^-$ **(B)** $\underline{N}H_3 + H^+ \longrightarrow \underline{N}H_4^+$

(C) $2\,\underline{S}O_2 + O_2 \longrightarrow 2\,\underline{S}O_3$ **(D)** $H_2\underline{O} + H^+ \longrightarrow H_3\underline{O}^+$

10. According to Molecular orbital theory which of the following is incorrect ?

(A) LUMO level for C_2 molecule is σ_{2p_x} orbital

(B) In C_2 molecules both the bonds are π bonds

(C) In C_2^{2-} ion there is one σ bonds and two π bonds.

(D) C_2 is paramagnetic but C_2^{2-} is diamagnetic.

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

11. Which of the following statements is/are true for P_4S_3 molecule ?

(A) It contains six P–S bonds and three P–P bonds.

(B) It contains six P–S bonds and ten lone pairs.

(C) It has all atoms sp^3 hybridised.

(D) It contains six P–P bonds and ten lone pairs.

12. Which of the following is polar ?

(A) XeF_4 **(B)** XeF_6 **(C)** $XeOF_4$ **(D)** XeF_5^-

13. Hydrogen bonding is present in which of the following species?

(A) CH_3NH_2 **(B)** CH_3^- **(C)** CH_3COOH **(D)** $CCl_3CH(OH)_2$

14. Correct 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) $ClO_2 > H_2O > H_2S > SF_6$

15. Which of the following molecule are polar sp^3d^2 hybridized

(A) IF_5 **(B)** XeF_4 **(C)** $XeOF_4$ **(D)** ICl_4^-

SECTION - III : ASSERTION AND REASON TYPE

16. **Statement-1** : Crystals of hydrated calcium sulphate (gypsum : $(CaSO_4 \,.\, 2\,H_2O)$ are soft and easily cleavedx.

Statement-2 : Crystals of anhydrous calcium sulphate (anhydrite : $CaSO_4$) are very hard and very difficult to cleave.

(A) Statement-1 is True, Statement02 is True ; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True ; Statement02 is NOT a correct explanation for Statement-1.

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True.

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17. **Statement-1** : Carbon has unique ability to form pπ – pπ multiple bonds with itself and with other atoms of small size and high electronegativity.

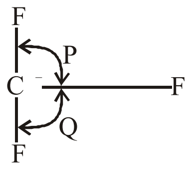
Statement-2 : Heavier elements of group 14th do not form pπ – pπ multiple bonds with itself because their atomic orbitals are too large and diffuse to have effective overlapping.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False.

(D) Statement-1 is False, Statement-2 is True.

18. **Statement-1** : 

bond angle P = bond angle Q but not precisely 90°

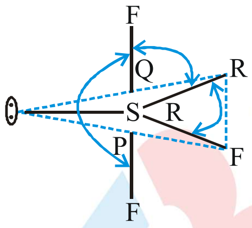
Statement - 2 : The molecule is slightly bent T-shaped and there is repulsion between lone pairs of electrons.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False.

(D) Statement-1 is False, Statement-2 is True.

19. **Statement - 1** : 

Bond angle R is a normal triangular angle 120°.

Statement - 2 : $\angle P \neq 180°$; $\angle Q \neq 90°$ and thus $\angle R \neq 120°$ but less than 120° due to the presence of a lone pair.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False.

(D) Statement-1 is False, Statement-2 is True.

20. **Statement - 1** : Compounds oh Hg^{2+} ions having an ionic radius of 116 pm are more covalent in character than those of Ca^{2+} ions with almost identical size (114 pm) and the same charge.

Statement - 2 : For two ions of same size and charge, one with an $(n-1)d^{10}ns^0$, electronic configuration will be more polarizing than a cation with an $(n-1)s^2\ (n-1)p^6\ ns^0$, electronic configuration.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False.

(D) Statement-1 is False, Statement-2 is True.

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SECTION - IV : COMPREHENSION TYPE

Read the following comprehensions carefully and answer the questions.

Comprehension # 1

When anions and cations approach each other, the valence shell of anions are pulled towards a cation, is known as polarisation and ability of a cation to polarize the anion is called as polarising power of cation. Due to polarisation, sharing of electrons occurs between two ions to some extent and bond shows some covalent character. Fajan's suggested following factors on which polarisation depend.

(i) As the charge on cation or anion increases polarisation increases.

(ii) Size of cation decreases or size of anion increases, polarisation increases.

(iii) Cation with pseudo noble gas configuration shows higher polarisation power than that with inert gas configuration.

21. Arrange the following compounds in increasing order of covalent character.

(i) $SiCl_4$ (ii) $MgCl_2$ (iii) NaCl (iv) $AlCl_3$

(A) $NaCl < MgCl_2 < AlCl_3 < SiCl_4$

(B) $SiCl_4 < AlCl_3 < MgCl_2 < NaCl$

(C) $NaCl < MgCl_2 < SiCl_4 < AlCl_3$

(D) $SiCl_4 < AlCl_3 < NaCl < MgCl_2$

22. Which one is the most ionic ?

(A) P_4O_{10} **(B)** TiO_2 **(C)** SnO **(D)** SO_3

23. Highest polarisation is shown in the following compounds ?

(A) $MgCl_2$ **(B)** $BaCl_2$ **(C)** AgCl **(D)** AgI

Comprehension # 2

The distribution of electrons among various molecular orbitals is called the electronic configuration of the molecule which provides us the following very important informations about the molecule.

(A) Stability Of molecule : The molecule is stable if number of bonding molecular orbital electrons (N_b) is greater than the number of antibonding molecular orbitals electrons (N_a).

(B) Bond Order : Bond order = $\frac{1}{2}(N_b - N_a)$

A positive bond order means a stable molecule while a negative or zero bond order means an unstable molecule.

(C) Nature of the Bond : Bond order 1, 2 and 3 corresponds to a single, double and triple bond respectively.

(D) Bond Length : Bond length decreases as bond order increases

(E) Magnetic Nature : Molecular orbitals in a molecule are doubly occupied, the substance is diamagnetic and if one or more molecular orbitals are singly occupied, it is paramagnetic.

24. Which one of the following statement is incorrect ?

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

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

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

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

25. 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

26. N_2 has greater dissociation energy than N_2^+, where as O_2 has a lower dissociation energy than O_2^+ because :

(A) bond order is reduced when O_2 is ionized to O_2^+ and bond order is increased when N_2 is ionized to N_2^+.

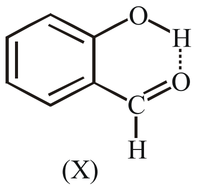
(B) bond order is increased when O_2 is ionized to O_2^+ and bond order is decreased when N_2 is ionized to N_2^+

(C) bond order is decreased when O_2 is ionized to O_2^+ and bond order is decreased when N_2 is ionized to N_2^+

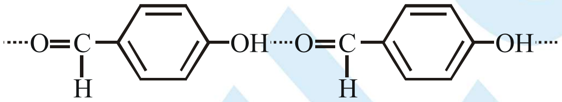
(D) none of these

Comprehension # 3

Hydrogen bonding :



(X)



(Y)

27. Which of the following species shows the same type of bonding as found in (X) ?

(A) Crystalline potassium bicarbonate **(B)** Fromic acid

(C) Anion of Caro's acid **(D)** Sulphuric acid

28. Which of the following can not be explained by (Y) type of bondig?

(A) The hydrolysis of NCl_3 to NH_3.

(B) The p-hydroxybenzaldehyde as high melting solid at room temperature

(C) Extra stability of the complex of Ni(II) with dimethylglyoxime.

(D) The hygroscopic nature of sodium peroxide.

29. Select the incorrect statement for (X) and (Y).

(A) p-hydroxy benzoic acid the higher boiling point than o-hydroxy benzoic acid on account of (Y).

(B) Boric acid crystal breaks quite easily into very fine particles because of (X).

(C) HF exists as zig-zag chains, $(HF)_n$ in solid as well as in liquid because of (Y).

(D) The higher k_1 value than k_2 for maleic acid is because of (X).

SECTION - V : MATRIX - MATCH TYPE

30. Match the species listed in column I with hybridisation of central atom listed in column II.

Column I	Column II
(A) $IO_2F_2^-$	**(p)** sp^3d
(B) F_2SeO	**(q)** sp^3
(C) $ClOF_3$	**(r)** sp^2
(D) XeF_5^+	**(s)** sp^3d^2

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31. Match the species listed in column I with shape(s) listed in column II.

Column I	**Column II**
(A) ClF_2^-, ClF_2^+	**(p)** Square pyramidal
(B) $IO_2F_2^-$, F_2SeO	**(q)** See-saw and pyramidal molecular geometry respectively
(C) IOF_4^-, $XeOF_2$	**(r)** Linear and bent respectively
(D) BrF_5, $XeOF_4$	**(s)** Square pyramidal and T – shaped respectively.

32. Match the compounds listed in column I with characteristic(s) listed in column II.

Column I	**Column II**
(A) SF_2	**(p)** sp^3 and bent
(B) KrF_4	**(q)** lone pair(s)
(C) NOCl	**(r)** Bond angle < 109°28’
(D) $N(Me)_3$	**(s)** sp^2 and bent
	(t) sp^3d^2 and square planar

33. Match the compounds listed in column I with type of bond(s) listed in column II

Column I	**Column II**
(A) Blue vitriol	**(p)** Ionic bond
(B) Gypsum	**(q)** Covalent bond
(C) Pure orthophosphoric acid	**(r)** Hydrogen bond
(D) Chloral hydrate	**(s)** Co-ordinate bond

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ANSWER KEY

EXERCISE - 1

1. C 2. B 3. B 4. B 5. C 6. B 7. B 8. D 9. C 10. D 11. C 12. D 13. B
14. D 15. D 16. D 17. D 18. B 19. A 20. B 21. C 22. C 23. C 24. C 25. B 26. D
27. A 28. B 29. A 30. C 31. A 32. C 33. C 34. C 35. A 36. B 37. D 38. D 39. D
40. D 41. B 42. B 43. A 44. A 45. B 46. D 47. B 48. C 49. A 50. D 51. A 52. C
53. D 54. B 55. C 56. B 57. A 58. C 59. B 60. B 61. B 62. A 63. B 64. B 65. A
66. C 67. D 68. D 69. D 70. C 71. B 72. A 73. C 74. B 75. B 76. C 77. B 78. D
79. B 80. D 81. D 82. D 83. D 84. D 85. A 86. C 87. C 88. D 89. C 90. B 91. A
92. C 93. A 94. C 95. A 96. A 97. D 98. C 99. D 100. A 101. D 102. B 103. A 104. A
105. C 106. A 107. B 108. A 109. A 110. D 111. C 112. C 113. D 114. B 115. C 116. C 117. C
118. A 119. D 120. B 121. A 122. A 123. D 124. C 125. D 126. C 127. D 128. C 129. C 130. D
131. D 132. A 133. C 134. B 135. D 136. C 137. A 138. C 139. D 140. D 141. B 142. A 143. D
144. D 145. A 146. C 147. A 148. D 149. C 150. A 151. A 152. A 153. D 154. B 155. D 156. B
157. D 158. D 159. A 160. C 161. C 162. D 163. B 164. D 165. B 166. B 167. C 168. B 169. D
170. C

EXERCISE - 2 : PART # I

1. B, C, D 2. B,C 3. A, B, C, D 4. B, C
5. B, C 6. B, D 7. A, B 8. A, B, C
9. A, C 10. A, B 11. B, C, D 12. A, C
13. A, B, C, D 14. B, C 15. B, D 16. A, B, C
17. A, C 18. C, D 19. B, C 20. A, C, D
21. A, B, C 22. B, C 23. A, B, C 24. B, D
25. D 26. A,B,C 27. A, B, C, D 28. A, B, D
29. B, C, D 30. A, B, C 31. B, C, D 32. B, C, D
33. A, B, C 34. B, D 35. A, B, C, D 36. A, B, C
37. A, B,D 38. B, C, D 39. A, B, C, D 40. A, B, D
41. A, B, C, D 42. A, B, C, D 43. B, C, D 44. B, C, D
45. B, D 46. A, B, D 47. D 48. B, C
49. A, C 50. A 51. A 52. C 53. C 54. B 55. B 56. A 57. D 58. D 59. D 60. C
61. A 62. A 63. B 64. A 65. A 66. D 67. D 68. A 69. D 70. A 71. D 72. C 73. B
74. A 75. D 76. B 77. A 78. B 79. C 80. D 81. C 82. D 83. D 84. D 85. D 86. D
87. D 88. B 89. B 90. D 91. C 92. C 93. C 94. A 95. B 96. D 97. C 98. D 99. B
100. C 101. B 102. B 103. A 104. B 105. C 106. D 107. C 108. C 109. B 110. B 111. B 112. B
113. C 114. D 115. C 116. D 117. C 118. C 119. A 120. D 121. C 122. D 123. A 124. D 125. A
126. A

PART # II

1. B 2. D 3. C 4. B 5. A 6. C 7. D 8. A 9. A 10. D 11. A 12. B 13. B
14. A 15. D 16. A 17. B 18. A 19. A 20. B 21. As 22. D 23. B 24. A 25. A 26. A
27. A 28. D 29. C 30. A 31. D 32. A 33. A 34. A 35. A 36. B 37. A 38. B 39. C

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EXERCISE - 3 : PART # I

1. A → (p), B → (q), C → (p), D → (s)
2. A → (p, q, r), B → (q, r, t), C → (s), D → (r)
3. A → (r), B → (q), C → (s), D → (p, t)
4. A → (q, s), B - (q, r, s), C → (p, q), D → (q, s)
5. A → (r, s), B → (p, q, s), C → (q), D - (q, r)
6. A → (p, r), B → (p, q, s), C → (q, s), D → (p, r)
7. A → (q), B → (r), C → (s, p), D - (p)
8. A → (r), B → (p), C → (s), D → (q)
9. A → (r), B → (s), C → (p), D - (q)
10. A → (p, r), B → (p, q), C → (p, r), D → (p, q, s)
11. A → (p, q, r, s), B → (p, q, r, s), C → (q, r), D → (q, r)
12. A → (r), B → (p, q, r), C → (p, q, r), D → (p, r), E → (p, r, s)
13. A → (p, q, r, s), B → (p, q, r, s), C → (p, q, r, s), D → (r, s)

PART # II

Comprehension # 1 : **1.** C **2.** D **3.** D **4.** A,C **5.** A,B,C
Comprehension # 2 : **1.** D **2.** D 3. B
Comprehension # 3 : **1.** D 2. A **3.** C **4.** A **5.** D
Comprehension # 4 : **1.** B **2.** B 3. C
Comprehension # 5 : **1.** C **2.** C
Comprehension # 6 : **1.** A 2. A **3.** C

EXERCISE - 5 : PART # I

1. 1 **2.** 2 **3.** 3 **4.** 1 **5.** 4 **6.** 3 **7.** 2 **8.** 4 **9.** 4 **10.** 3 **11.** 3 **12.** 4 **13.** 1
14. 3 **15.** 4 **16.** 1 **17.** 1 **18.** 4 **19.** 2 **20.** 3 **21.** 4 **22.** 2 **23.** 1 **24.** 4 **25.** 1 **26.** 3
27. 1 **28.** 4 **29.** 4 **30.** 3 **31.** 1 **32.** 2 **33.** 2 **34.** 4 **35.** 4 **36.** 4 **37.** 1 **38.** 4 **39.** 2
40. 1 **41.** 2 **42.** 3

PART # II

1. B **2.** D **3.** D **4.** D **5.** A **6.** C **7.** D **8.** C **9.** C
10. A → (P,Q,R,T) ; B → Q,R,S,T ; C → (P,Q,R) ; D → (P,Q,R,S) **11.** A,B,C **12.** B,C **13.** D **14.** A **15.** B
16. B **17.** D **18.** A,B,C **19.** B,D **20.** C **21.** 8 **22.** 4 **23.** B,C **24.** B **25.** B,C **26.** A, C

Subjective Questions

27. $KO_2 > O_2 > O_2[AsF_4]$ **28.** 4 **29.** 0 **30.** 3 **31.** 6 **32.** 2 **33.** 5 **34.** 6 **35.** 5 or 6

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MOCK TEST

1.	B	**2.**	D	**3.**	A	**4.**	D	**5.**	C
6.	D	**7.**	D	**8.**	D	**9.**	A	**10.**	D
11.	A,B,C	**12.**	B,C	**13.**	A,C,D	**14.**	A,B,D	**15.**	A,C
16.	B	**17.**	B	**18.**	A	**19.**	D	**20.**	A
21.	A	**22.**	C	**23.**	D	**24.**	D	**25.**	A
26.	B	**27.**	C	**28.**	C	**29.**	B		

30. $A \rightarrow (p), B \rightarrow (q), C \rightarrow (s), D \rightarrow (p)$

31. $A \rightarrow (r), B \rightarrow (q), C \rightarrow (s), D \rightarrow (p)$

32. $A \rightarrow (p, q, r), B \rightarrow (q, r, t), C \rightarrow (q, s), D \rightarrow (r)$

33. $A \rightarrow (p, q, r, s), B \rightarrow (p, q, r, s), C \rightarrow (q, r), D \rightarrow (q, r)$

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