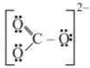
Speed Test-32

1. **(b)** Electronic configuration reveals it is monovalent (in fact Na) hence its oxide will be M_2O.

2. **(c)** CO_3^{2-} Its structure is 

3. **(c)** Formation of positive ion involves removal of electron(s) from neutral atom and that of the negative ion involves addition of electron(s) to the neutral atom.

4. **(a)** Hybridisation $= \frac{1}{2}\left[\begin{pmatrix}\text{No. of electrons}\\ \text{in valence}\\ \text{shell of atom}\end{pmatrix} + \begin{pmatrix}\text{No.of monovalent}\\ \text{atoms around it}\end{pmatrix} - \begin{pmatrix}\text{charge on}\\ \text{cation}\end{pmatrix} + \begin{pmatrix}\text{charge on}\\ \text{anion}\end{pmatrix}\right]$

   (a) For AlH_3,

   Hybridisation of Al atom $= \frac{1}{2}[3+3-0+0] = 3 = sp^2$

   For AlH_4^-,

   Hybridisation of Al atom $= \frac{1}{2}[3+4-0+1] = 4 = sp^3$

   (b) For H_2O,

   Hybridisation of O atom $= \frac{1}{2}[6+2-0+0] = 4 = sp^3$

   For H_3O^+, Hybridisation of O atom $= \frac{1}{2}[6+3-1+0]$ $= 4 = sp^3$

   (c) For NH_3

   Hybridisation of N atom $= \frac{1}{2}[5+3-0+0] = 4 = sp^3$

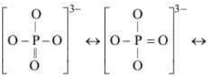
   For NH_4^+, Hybridisation of N atom $= \frac{1}{2}[5+4-1+0]$ $= 4 = sp^3$

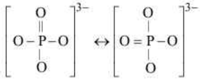
   Thus hybridisation changes only in option (a).

5. **(b)** The bond angle decreases on moving down the group due to decrease in bond pair-bond pair repulsion.

NH_3	PH_3	AsH_3	SbH_3	BiH_3
107º	93.5º	91.8º	91.3º	90º

   NOTE : This can also be explained by the fact that as the size of central atom increases sp^3 hybrid orbital becomes more distinct with increasing size of central atom i.e. pure p- orbitals are utilized in M–H bonding

6. **(c)** 



Bond order

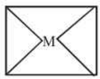
$$= \frac{\text{Number of bonds}}{\text{Number of Resonating structures}} = \frac{5}{4} = 1.25$$

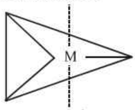
Three unit negative charge is being shared by four O atoms. Formal charge = –3/4

7. **(c)** Since F form H-bond $[HF_2]^-$ exists. Therefore KHF_2 gives $K^+ + HF_2^-$

8. **(d)** In alcohol intermolecular H-bonding is possible whereas in ether it is not possible.

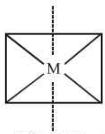
9. **(c)** (a) N_2 : bond order 3, paramagnetic
   N_2^- : bond order, 2.5, paramagnetic
   (b) C_2 : bond order 2, diamagnetic
   C_2^+ : bond order 1.5, paramagnetic
   (c) NO : bond order 2.5, paramagnetic
   NO^+ : bond order 3, diamagnetic
   (d) O_2 : bond order 2, paramagnetic
   O_2^+ : bond order 2.5, paramagnetic

10. **(d)** 



   dsp^2 hybridisation — sp^3d or dsp^3 hybridisation

   Number of 90° angle between bonds = 4 — Number of 90° angle between bonds = 6



   sp^3d^2 hybridisation
   Number of 90° angle between bonds = 12

11. **(c)** It is due to H - bonding.

12. **(d)** In XeF_2 Total number of valence electrons of Xe = 8, two electrons shared with 2F atoms, 6 electrons left hence 3 lone pairs, in XeF_4 4 shared with 4 F atoms 4 left hence 2 lone pairs; in XeF_6 6 shared with 6 F atoms 2 left hence 1 lone pair.

13. **(b)** $NO_2^+ = \frac{1}{2}[5+0+0-1] = 2\,sp$; $NO_2^- = \frac{1}{2}[5+0+1-0]$

$= 3\,sp^2$; $NH_4^+ = \frac{1}{2}[5+4+0-1] = 4\,sp^3$

14. **(b)** $NH_3 \rightarrow$ 1l.p, 3b.p $\rightarrow$ Trigonal pyramidal

$SO_2 \rightarrow$ 1l.p, 2b.p $\rightarrow$ Bent

$SF_4 \rightarrow$ 1l.p, 4b.p $\rightarrow$ See-saw

$ClF_3 \rightarrow$ 2l.p, 3b.p $\rightarrow$ T-shape

15. **(b)** Atomic orbitals having same or nearly same energy will not combine if they do not have the same symmetry. $2p_z$ Orbital of one atom cannot combine with $2p_x$ or $2p_y$ orbital of other atom because of their different symmetries.

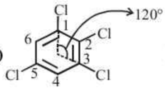
16. **(a)** The number of lone pairs of electrons on central atom in various given species are

Species	Number of lone pairs on central atom
IF_7	nil
IF_5	1
ClF_3	2
XeF_2	3

Thus the correct increasing order is

$IF_7 < IF_5 < ClF_3 < XeF_2$

0 1 2 3

17. **(c)** 

Dipole moments of 2Cl and 5 Cl are vectorically cancelled (opposite in direction).

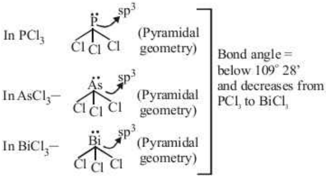
and now for 1 Cl and 3 Cl, $\mu^2 = \mu_1^2 + \mu_2^2 + 2\mu_1\mu_2\cos\theta$

$= (1.5)^2 + (1.5)^2 + 2\times1.5\times1.5\cos120$

$\therefore\ \mu = 1.5\,D$

18. **(b)** BCl_3: Cl−B(Cl)Cl; sp^2 - Hybridisation

(Trigonal geometry); Bond angle = 120°



In these, order of bond angle : $BCl_3 > PCl_3 > AsCl_3 > BiCl_3$

19. **(d)** According to Fajan's rule :

Covalent character $\propto \frac{1}{\text{size of cation}}$

$\propto$ size of anion

Among the given species order of size of cations

$N^{3+} < O^{2+} < Pb^{2+} < Ba^{2+}$

order of size of anions $O^{2-} < Cl^-$.

Hence the order of covalent character is

$NCl_3 > Cl_2O > PbCl_2 > BaCl_2$

$BaCl_2$ is most ionic in nature.

20. **(c)** Let amount of compound = 100 g

No. of moles of C $= \frac{92.3}{12} = 7.69 = 7.7$

No. of moles of H $= \frac{7.7}{1} = 7.7$

Empirical formula = CH

Empirical formula mass = 12 + 1 = 13 g/mol

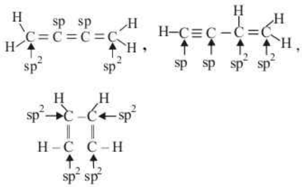
Molecular mass = 52 g/mol

$n = \frac{52}{13} = 4$

$\therefore$ Molecular foumula = Empirical formula × 4

$= C_4H_4$

Possible structures



21. **(a)** NO_3^- and CO_3^{2-} both have same number of electrons (equal to 32) and central atom in each being sp^2 hybridised, are isostructural too.

22. **(d)** The hybrid state of N in NO_3^- and NO_2^- is the same and it is sp^2 while in NO_2^+ it is sp

23. **(d)** The molecular orbital configuration of the given molecules is

$H_2 = \sigma1s^2$ (no electron anti-bonding)

$Li_2 = \sigma1s^2\,\sigma^*1s^2\,\sigma2s^2$(two anti-bonding electrons)

$B_2 = \sigma1s^2\,\sigma^*1s^2\,\sigma2s^2\,\sigma^*2s^2\left\{\pi2p_y^1 = \pi2p_z^1\right\}$

(4 anti-bonding electrons)

Though the bond order of all the species are same (B.O = 1) but stability is different. This is due to difference in the presence of no. of anti-bonding electron.

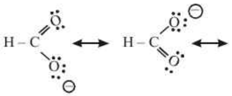
Higher the no. of anti-bonding electron lower is the stability hence the correct order is $H_2 > Li_2 > B_2$

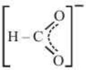
24. (b) The formation of a heavy nucleus from those of lighter elements is known as nuclear fusion. The mass of the heavier nucleus is always less than the sum of masses of lighter nuclei which is converted into energy according to Einstein equation $E = mc^2$.

25. (a) A gaseous HCl molecule has hydrogen and chlorine linked by a covalent bond. Here electronegativity of chlorine is greater than that of hydrogen. Due to this the shared pair of electron is more attracted towards chlorine. Thus, chlorine end of molecule has higher electron density and becomes slightly negative and the hydrogen and slightly positive. Hence the covalent bond in HCl has a polar character as shown below

$$\overset{\delta^+}{H} \longrightarrow \overset{\delta^-}{Cl}$$

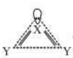
26. (c) Hybridisation in NF_3 and H_3O^+ is sp^3 and they have pyramidal shape. Hybridisation in NO_3^- and BF_3 is sp^2 and they have triangular planar shape.

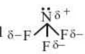
27. (c)  or Resonance

hybrid  due to resonance C – O bond length is the same.

28. (d) Promotion of electron is not an essential condition prior to hybridisation. It is not necessary that only half filled orbitals participate in hybridisation. In some cases, even filled orbitals of valence shell take part in hybridisation.

29. (b) Since XY_2 forms $2\sigma, 2\pi$ bonds and has 1 lone pair of electrons. It must have the structure $Y = \ddot{X} = Y$. Hence Y is divalent. The hybridisation of X is $sp^2\left(\frac{1}{2}(6+0+0-0)=3\right)$. So XY_2 is trigonal planar

 (like SO_2).

30. (d) The shape of BF_3 is trigonal planar  and $\mu = 0$ hence it is non polar. The shape of NF_3 is pyramidal  and $\mu \neq 0$ hence it is polar.

31. (b) According to Fajan's rules smaller, highly charged cation has greatest covalent character while large cation with smaller charge has greatest ionic character.

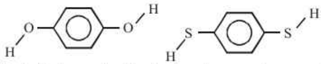
32. (d)

(a) $\left.\begin{array}{l} ONCl = 8+7+17 = 32e^- \\ ONO^- = 8+7+8+1 = 24e^- \end{array}\right\}$ not isoelectronic

(b)  The central atom is sp^2 hybridized with one lone pair.

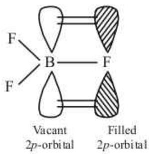
(c) It is a pale blue gas. At – 249.7°, it forms violet black crystals.

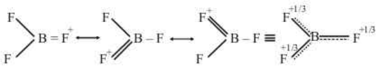
(d) It is diamagnetic in nature due to absence of unpaired electrons.

33. (d) 

In both the molecules the bond moments are not cancelling with each other and hence the molecules has a resultant dipole and hence the molecule is polar.

34. (b) The delocalised $p\pi - p\pi$ bonding between filled *p*-orbital of F and vacant *p*-orbital of B leads to shortening of B–F bond length which results in higher bond dissociation energy of the B–F bond.





35. (b) This type of attractive force operates between the polar molecules having permanent dipole and the molecules lacking permanent dipole.
HCl is polar ($\mu \neq 0$) and He is non polar ($r \neq 0$), thus gives dipole-induced dipole interaction.

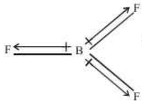
36. (d) The structure of CaC_2 is $Ca^{2+}[:C \equiv C:]^{2-}$
i.e, one π and two σ bonds

37. (d) Bond lengths are measured by spectroscopic, X-ray diffraction and electron diffraction techniques.

38. (c) In CO (three shared electron pairs between C and O) the bond order is 3. For N_2 bond order is 3 H_2, Cl_2, Br_2 have identical Bond order, Bond order 1.

39. (a) The molecule does not exist for a certain fraction of time in one cannonical form and for other fractions of time in other cannonical forms.

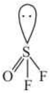
40. (b) BF_3 has planar and symmetrical structure thus as a result the resultant of two bond moments, being equal and opposite to the third, cancels out and hence molecule possess zero dipole moment.



$;\mu = 0$

41. (d) OSF_2: $H = \frac{6+2}{2} = 4$. sp^3 hybridization.

It has 1 lone pair and 3-bond pair.



(Shape is trigonal pyramidal)

The shapes of SO_3, BrF_3 and SiO_3^{2-} are triangular planar respectively.

42. (b) $(O_2) = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2,$

$\pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^1 = \pi^* 2P_y^1$

Bond order $= \frac{N_b - N_a}{2} = \frac{10-6}{2} = \frac{4}{2} = 2$

$(O_2^+ \text{ ion}) = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2,$

$\pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^1$

Bond order $\frac{N_b - N_a}{2} = \frac{10-5}{2} = \frac{5}{2} = 2\frac{1}{2}$

$(O_2^-) = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2P_z^2,$

$\pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^2 = \pi^* 2p_y^1$

Bond order $= \frac{(N_b - N_a)}{2} = \frac{10-7}{2} = \frac{3}{2} = 1\frac{1}{2}$

$(O_2^{2-}) = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2,$

$\pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^2 = \pi^* 2p_y^2$

Bond order $\frac{N_b - N_a}{2} = \frac{10-8}{2} = \frac{2}{2} = 1$

43. (a) Nitric oxide is paramagnetic in the gaseous state because of the presence of one unpaired electron in its outermost shell.
The electronic configuration of NO is

$\sigma_{1s}^2\, \sigma_{1s}^{*2}\, \sigma_{2s}^2 \sigma_{2s}^{*2} \sigma_{2p_z}^2\, \pi_{2p_x}^2 = \pi_{2p_y}^2\, \pi_{2\ p_x}^{*1}$

44. (d) Smaller the size and higher the charge more will be polarising power of cation. Since the order of the size of cation is $K^+ > Ca^{2+} > Mg^{2+} > Be^{2+}$. So the correct order of polarising power is
$K^+ < Ca^{2+} < Mg^{2+} < Be^{2+}$

45. (c) $H_2^{2+} = \sigma 1s^0\, \sigma^* 1s^0$

bond order for $H_2^{2+} = \frac{1}{2}(0-0) = 0$

$He_2 = \sigma 1s^2 \sigma^* 1s^2$

bond order for $He_2 = \frac{1}{2}(2-2) = 0$

so both H_2^{2+} and He_2 do not exist