CHEMICAL BONDING

1. The dipole moments of CCl_4, $CHCl_3$ and CH_4 are in the order :
(1) $CH_4 = CCl_4 < CHCl_3$
(2) $CH_4 < CCl_4 < CHCl_3$
(3) $CCl_4 < CH_4 < CHCl_3$
(4) $CHCl_3 < CH_4 = CCl_4$

2. The relative strength of interionic/ intermolecular forces in decreasing order is :
(1) ion-dipole > ion-ion > dipole-dipole
(2) dipole-dipole > ion-dipole > ion-ion
(3) ion-dipole > dipole-dipole > ion-ion
(4) ion-ion > ion-dipole > dipole-dipole

3. The bond order and the magnetic characteristics of CN^- are :
(1) 3, diamagnetic
(2) $2\frac{1}{2}$, paramagnetic
(3) 3, paramagnetic
(4) $2\frac{1}{2}$, diamagnetic

4. The predominant intermolecular forces present in ethyl acetate, a liquid, are :
(1) hydrogen bonding and London dispersion
(2) Dipole-dipole and hydrogen bonding
(3) London dispersion and dipole-dipole
(4) London dispersion, dipole-dipole and hydrogen bonding

5. Arrange the following bonds according to their average bond energies in descending order : C–Cl, C–Br, C–F, C–I
(1) C–I > C–Br > C–Cl > C–F
(2) C–Br > C–I > C–Cl > C–F
(3) C–F > C–Cl > C–Br > C–I
(4) C–Cl > C–Br > C–I > C–F

6. 'X' melts at low temperature and is a bad conductor of electricity in both liquid and solid state. X is :
(1) Carbon tetrachloride (2) Mercury
(3) Silicon carbide (4) Zinc sulphide

7. If the magnetic moment of a dioxygen species is 1.73 B.M, it may be :
(1) O_2^- or O_2^+ (2) O_2 or O_2^+
(3) O_2 or O_2^- (4) O_2, O_2^- or O_2^+

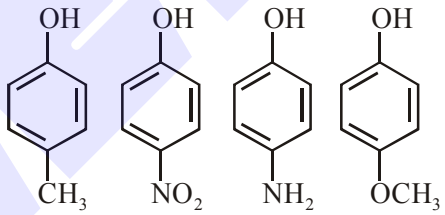
8. The acidic, basic and amphoteric oxides, respectively, are :
(1) MgO, Cl_2O, Al_2O_3
(2) Cl_2O, CaO, P_4O_{10}
(3) Na_2O, SO_3, Al_2O_3
(4) N_2O_3, Li_2O, Al_2O_3

9. The number of sp^2 hybrid orbitals in a molecule of benzene is :
(1) 24 (2) 6 (3) 12 (4) 18

10. Among the sulphates of alkaline earth metals, the solubilities of $BeSO_4$ and $MgSO_4$ in water, respectively, are:
(1) high and high (2) poor and poor
(3) high and poor (4) poor and high

11. The number of CI = O bonds in perchloric acid is, "_____"

12. The increasing order of boiling points of the following compounds is :



I II III IV
(1) I < IV < III < II
(2) IV < I < II < III
(3) I < III < IV < II
(4) III < I < II < IV

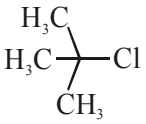
13. The compound that has the largest H–M–H bond angle (M=N, O, S, C), is :
(1) H_2O (2) CH_4
(3) NH_3 (4) H_2S

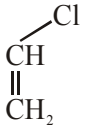
14. Hydrogen peroxide, in the pure state, is :
(1) non-planar and almost colorless
(2) linear and almost colorless
(3) planar and blue in color
(4) linear and blue in color

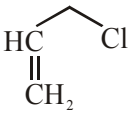
15. The structure of PCl_5 in the solid state is
(1) square pyramidal
(2) tetrahedral $[PCl_4]^+$ and octahedral $[PCl_6]^-$
(3) square planar $[PCl_4]^+$ and octahedral $[PCl_6]^-$
(4) trigonal bipyramidal

16. Among the following compounds, which one has the shortest C—Cl bond ?

(1) $H_3C–Cl$

(2) 

(3) 

(4) 

17. The reaction in which the hybridisation of the underlined atom is affected is :-

(1) $\underline{N}H_3 \xrightarrow{H^+}$

(2) $\underline{Xe}F_4 + SbF_5 \rightarrow$

(3) $H_2\underline{S}O_4 + NaCl \xrightarrow{420\ K}$

(4) $H_3\underline{P}O_2 \xrightarrow{\text{Disproportionation}}$

18. Of the species, NO, NO^+, NO^{2+}, NO^-, the one with minimum bond strength is :

(1) NO^{2+} (2) NO^+ (3) NO (4) NO^-

19. In a molecule of pyrophosphoric acid, the number of P–OH, P=O and P–O–P bonds/ moiety(ies) respectivey are :

(1) 3, 3 and 3 (2) 2, 4 and 1

(3) 4, 2 and 0 (4) 4, 2 and 1

20. Match the type of interaction in Column A with the distance dependence of their interaction energy in Column B :

A	B
(I) ion - ion	(a) $\frac{1}{r}$
(II) dipole - dipole	(b) $\frac{1}{r^2}$
(III) London dispersion	(c) $\frac{1}{r^3}$
	(d) $\frac{1}{r^6}$

(1) (I)-(a), (II)-(b), (III)-(c)

(2) (I)-(a), (II)-(c), (III)-(d)

(3) (I)-(a), (II)-(b), (III)-(d)

(4) (I)-(b), (II)-(d), (III)-(c)

21. The molecular geometry of SF_6 is octahedral. What is the geometry of SF_4 (including lone pair(s) of electrons, if any) ?

(1) Trigonal bipyramidal

(2) Square planar

(3) Tetrahedral

(4) Pyramidal

22. If AB_4 molecule is a polar molecule, a possible geometry of AB_4 is :

(1) Square pyramidal

(2) Tetrahedral

(3) Square planar

(4) Rectangular planar

23. The shape/structure of $[XeF_5]^-$ and XeO_3F_2, respectively, are :

(1) pentagonal planar and trigonal bipyramidal

(2) trigonal bipyramidal and pentagonal planar

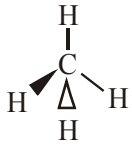
(3) octahedral and square pyramidal

(4) trigonal bipyramidal and trigonal bipyramidal

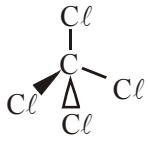
SOLUTION

1. NTA Ans. (1)

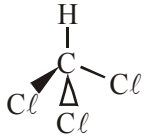
Sol.



$\mu_{net} = 0$



$\mu_{net} = 0$



$\mu_{net} \neq 0$

2. NTA Ans. (4)

Sol. Order is

ion – ion > ion – dipole > dipole – dipole

3. NTA Ans. (1)

Sol. According to MOT (If z is internuclear axis) The configuration of

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

$$\text{Bond order} = \frac{1}{2}(10-4)$$

$$= 3$$

CN^- is diamagnetic due to absence of unpaired electron

4. NTA Ans. (3)

Sol. Ethyl acetate $\left(H_3C\text{–}\underset{\underset{O}{\|}}{C}\text{–}O\text{–}CH_2\text{–}CH_3 \right)$ is polar molecule. Hence there will be dipole-dipole attraction and london dispersion forces are present.

5. NTA Ans. (3)

Sol. Bond length order in carbon halogen bonds are in the order of C – F < C – Cl < C – Br < C – I

Hence, Bond energy order

C – F > C – Cl > C – Br > C – I

6. NTA Ans. (1)

Sol. CCl_4 is molecular solid so does not conduct electricity in liquid & solid state.

7. NTA Ans. (1)

Sol.

	number of unpaired electron	magnetic moment
$O_2^{\ominus}$	1	1.73 B.M
$O_2^{\oplus}$	1	1.73 B.M
O_2	2	2.83 BM

8. NTA Ans. (4)

Sol. 1. MgO Basic
Cl_2O Acidic
Al_2O_3 amphoteric

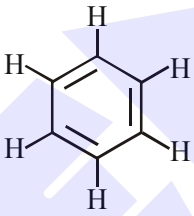
2. Cl_2O Acidic
CaO Basic
P_4O_{10} Acidic

3. Na_2O Basic
SO_3 Acidic
Al_2O_3 amphoteric

4. N_2O_3 Acidic
Li_2O Basic
Al_2O_3 amphoteric

9. NTA Ans. (4)

Sol.



Each carbon atom is sp^2 hybridized

Therefore each carbon has 3 sp^2 hybrid orbitals.

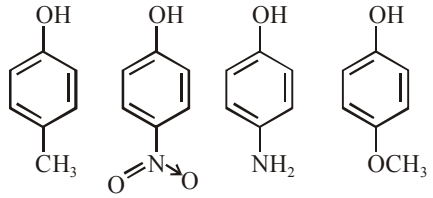
Hence total sp^2 hybrid orbitals are 18.

10. Official Ans. by NTA (1)

11. Official Ans. by NTA (3.00)

12. Official Ans. by NTA (1)

Sol.



	Ⅰ	Ⅱ	Ⅲ	Ⅳ
BP value from net	≃202°C	≃279°	≃284°C	≃243°C

BP ∝ dipolemoment (μ)

Alter

Increasing order of boiling point is :

I.

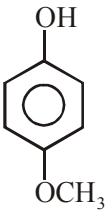
⇒ Shows hydrogen bonding from –O–H group only

II. 

⇒ Shows strongest hydrogen bonding from both sides of –OH group as well as $–NO_2$ group.

III. 

⇒ Shows stronger hydrogen from both side of –OH group as well as $–NH_2$ group.

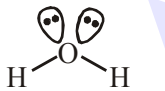
IV. 

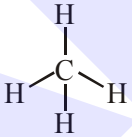
⇒ Shows stronger hydrogen bonding from one side –OH–group and another side of $–OCH_3$ group shows only dipole-dipole interaction.

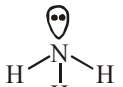
⇒ Hence correct order of boiling point is:

(I) < (IV) < (III) < (II)

13. Official Ans. by NTA (2)

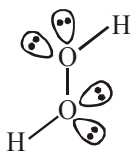
Sol. (1) 
sp^3, 104°5'

(2) 
sp^3, 109°28'

(3) 
sp^3, 107°

(4) 
92°

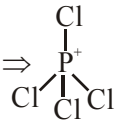
14. Official Ans. by NTA (1)

Sol. 

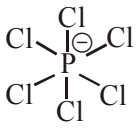
hydrogen peroxide, in the pure state, is non-planar and almost colourless (very pale blue) liquid.

15. Official Ans. by NTA (2)

Sol. $PCl_{5(s)}$ exist as $[PCl_4]^+$ and $[PCl_6]^-$

$[PCl_4]^+ \Rightarrow$  (sp^3 hybridisation)

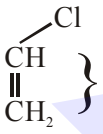
Tetrahedral

$[PCl_6]^- \Rightarrow$ 

octahedral

sp^3d^2 hybridization

16. Official Ans. by NTA (3)

Sol. 

In option (3) C—Cl bond is shortest due to resonance of lone pair of –Cl.

Due to resonance C—Cl bond acquire partial double bond character.

Hence C—Cl bond length is least.

17. Official Ans. by NTA (2)

Sol. $XeF_4 + SbF_5 \rightarrow [XeF_3]^+ [SbF_6]^-$

sp^3d^2 sp^3d sp^3d sp^3d^2

18. Official Ans. by NTA (4)

Sol. Bond order of NO^{2+} = 2.5

Bond order of NO^+ = 3

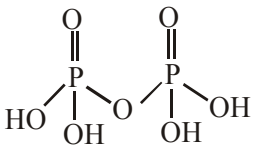
Bond order of NO = 2.5

Bond order of NO^- = 2

Bond order α bond strength.

19. Official Ans. by NTA (4)

Sol. Pyrophosphoric acid.



P – OH linkages = 4

P = O linkages = 2

P–O–P linkages = 1

20. Official Ans. by NTA (3)

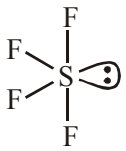
Official Ans. by ALLEN (2)

Sol.

Type of interaction	Interaction Energy(E)
ion - ion	$E \propto \frac{1}{r}$
dipole - dipole	$E \propto \frac{1}{r^3}$
London dispersion	$E \propto \frac{1}{r^6}$

21. Official Ans. by NTA (1)

Sol.

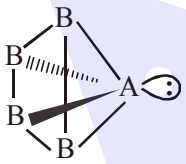


4σ bonds +1 lone pair

$\therefore$ Shape (including lone pair of electrons) is Trigonal bipyramidal

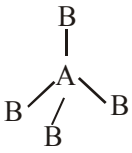
22. Official Ans. by NTA (1)

Sol. (1) If AB_4 molecule is a square pyramidal then it has one lone pair and their structure should be



and it should be polar because dipole moment of lone pair of 'A' never be cancelled by others.

(2) If AB_4 molecule is a tetrahedral then it has no lone pair and their structure should be

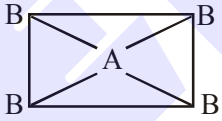


and it should be non polar due to perfect symmetry.

(3) If AB_4 molecule is a square planar then

it should be non polar because vector sum of dipole moment is zero.

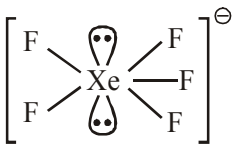
(4) If AB_4 molecule is a rectangular planar then

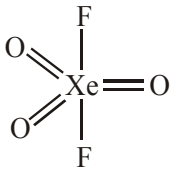


it should be non polar because vector sum of dipole moment is zero.

23. Official Ans. by NTA (1)

Sol.





XeF_5^-	XeO_3F_2
sp^3d^3	sp^3d
Pentagonal planar	Trigonal bipyramidal