QB365

Important Questions - Chemical Bonding and Molecular Structure

11th Standard CBSE

Chemistry

Reg.No. : | | | | | | |

Time : 01:00:00 Hrs

Total Marks : 50

Section-A

1) Why AlF_3 is a high melting solid whereas SiF_4 is a gas? **1**

2) Why is NaCl harder than sodium metal? **1**

3) Write the significance of a plus and a minus sign shown in representing the orbitals **1**

4) Which of the following molecules show super octet? **1**

CO_2, ClF_3, SO_2, IF_5

5) Define bonding molecular orbital **1**

6) Give reason the following. **1**

Ionic compounds have higher melting points than the covalent compounds.

7) Among the molecules, NO^+ , N_2, $SnCl_2$, and NO_2^- identify the species which is isoelectronic with CO. **1**

8) Arrange the bonds in order of increasing ionic character in the molecules: LiF, K_2O , N_2, SO_2 and ClF_3 . **1**

9) Arrange the following bonds in order of increasing ionic character giving reason. **1**

N-H, F-H, C-H and O-H

10) Arrange the following in order of decreasing bond angles. **1**

NH_3, NH_2^-, NH_4^+

Section-B

11) Is there any change in the hybridisation of B and N-atoms as a result of the reaction? **2**

$BF_3 + NH_3 \longrightarrow F_3B.NH_3$

12) Explain why HF is less viscous than H_2O **2**

13) Give correct reasons for the following **2**

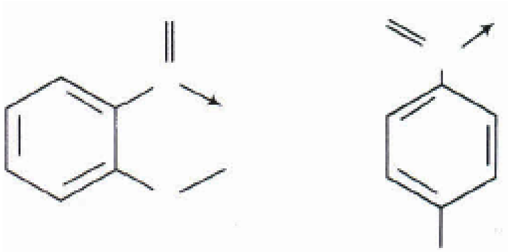
BF_3 has a zero dipole moment although the B-F bonds are polar.

14) Which is more polar : CO_2 or N_2O? Give reason. **2**

15) Why does formic acid exist as dimer? What is its one consequence? **2**

16) Structure of molecules of two compounds are given below: **2**

Which of the two compounds will have intermolecular hydrogen bonding and which compound is expected to show intramolecular hydrogen bonding?



17) Using valence bond theory, draw the molecular structures of OSF_4 and XeF_4 indicating the location of lone pairs(s) of electrons and hybridisation of central atoms **2**

18) Explain why PCl_5 is trigonal bipyramidal,whereas IF_5 is square pyramidal? **2**

19) Explain the shape of I_3^- ion **2**

20) Discuss the hybridisation of Be in gaseous state and solid state **2**

Section-C

21) Illustrate bonding and antibonding molecular orbitals based on homonuclear dihydrogen molecule. **5**

22) What is hydrogen bond? What requirements should a molecule fulfil for the formation of hydrogen bond? **5**

Explain the formation of hydrogen bond in HF and NH_3 molecules. Discuss intramolecular hydrogen bond.

23) Discuss the shape of the following molecules using VSEPR model **5**

$BeCl_2, BCl_3, SiCl_4, AsF_5, H_2S, PH_3$

24) Which hybrid orbitals are used by C-atoms in the following molecules? **5**

(i) $CH_3 - CH_3$

(ii) $CH_3CH = CH_2$

(iii) CH_3CH_2OH

(iv) CH_3CHO

(v) CH_3COOH

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Section-A

1) **1**

AlF_3 is an ionic compound whereas SiF_4 is a non-polar covalent compound. Hence, interparticle forces in AlF_3 are much stronger that's why it is a high melting solid.

2) **1**

This is because in NaCl, there is strong ionic bond between Na^+ and Cl^{-1} whereas in Na metal, there is weak metallic bond.

3) **1**

Orbitals are represented by waves functions. A plus sign in an orbital represents a positive wave function and a minus sign represents a negative wave function. Combination of two waves function having similar sign give bonding molecular orbitals, while that having opposite sign give antibonding molecular orbitals

4) ClF_3 and IF_5 are super octet molecules. **1**

5) **1**

6) **1**

Because of the presence of strong electrostatic forces of attraction melting points of ionic compounds are higher than that of covalent compounds.

7) Isoelectronic species are those species have same number of electrons but different nuclear charge. **1**

Electrons present in CO = 6+8+ = 14

Then, In NO^+ = 7+8-1 = 14

In N_2 = 7+7 = 14

In $SnCl_2$ = (very high)50+17 × 2 = 50+34 = 84

In NO_2^- = 7+16+1 = 24

8) Ionic character ∝ lattice energy **1**

$$\propto \frac{1}{size \quad of \quad ion} \propto charge \quad on \quad ion,$$

A non-polar molecule like N_2 has almost negligible ionic character.

∴ The order of ionic character is

$$N_2 < SO_2 < ClF_3 < K_2O < LiF$$

9) Greater is the electronegativity difference between the two bonded atoms, greater is the ionic character. **1**

	N-H	F-H	C-H and	O-H
Electronegativity difference	(3.0-2.1) =0.9	(4.0-2.1) = 1.9	(2.5-2.1) = 0.4	(3.5-2.1) = 1.4

Therefore, increasing order of ionic character of the given bonds is as follows.

C-H

10) **1**

$NH_4^+ > NH_3 > NH_3^-$

This is because all of them involve sp3 hybridisation. The number of lone pair of electrons present on N-atom are 0,1 and 2 respectively. Greater the number of lone pairs, greater is the repulsion and lesser is the bond angle.

Section-B

11) **2**

In BF_3 , there are 3 bond pairs 0 lone pair, so boron is sp^2 hybridised and in NH_3, there are 3 bond pairs and 1 lone pair, so nitrogen is sp^3 hybridised. After the reaction hybridisation of boron changes to sp^3 but hybridisation of nitrogen remains the same becuase N shares its lone pair with electron deficient B.

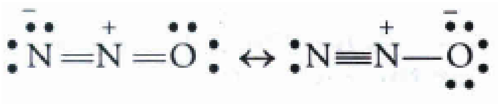
12) **2**

There is greater intermolecular hydrogen bonding in H_2O than that in HF as each H_2O molecule forms four H-bonds with water molecules,, whereas HF forms only H-bonds with other HF molecules. Greater the intermolecular H-bonding, greater is the viscosity. Hence, HF is less viscous than H_2O

13) **2**

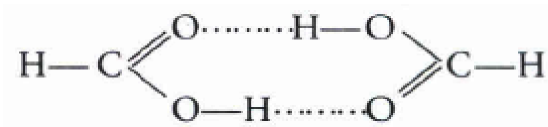
14) **2**

N_2O is more polar than CO_2 . This is because CO_2 is linear and symmetrical. Its net dipole moment is zero (O⇆C⇄O). N_2O . N_2O on the other hand, is linear but unsymmetrical. It is considered as a resonance hybrid of the following two structures



It has a net dipole moment of 0.116 D.

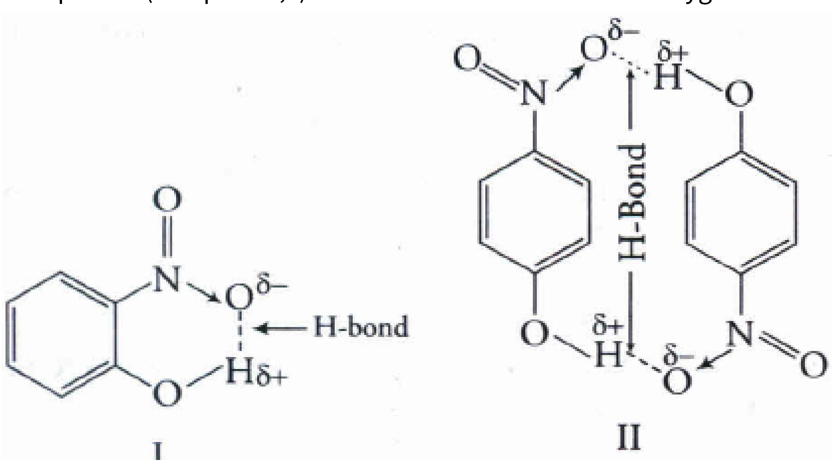
15) Formic acid exists as dimer because of hydrogen bonding **2**



Because of hydrogen bonding, it pretends larger size as well as molecular mass.

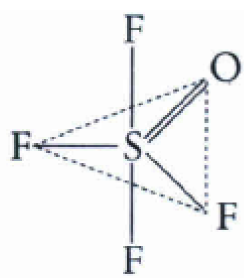
16) **2**

Compound (I) will form intramolecular H-bonding. Intramolecular H-bonding is formed when H-atom, in between the two highly electronegativity atoms, is present within the same molecule. In ortho-nitrophenol (compound, I) H-atom is in between the two oxygen atoms.

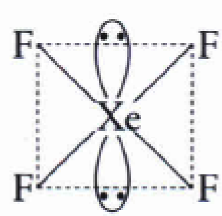


Compound II forms intermolecular H-bonding. In para-nitrophenol II there is a gap between NO_2 and OH group. so, H-bond exists between H-atom of one molecule and O-atom of another molecule as depicted below.

17) **2**



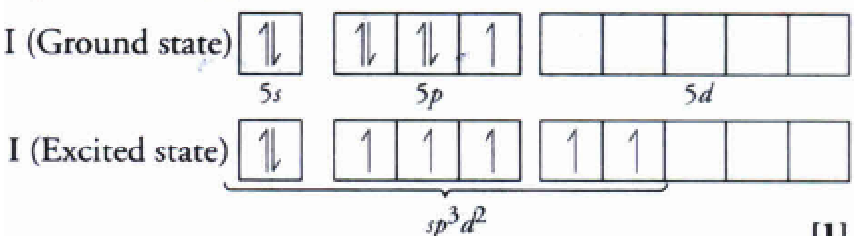
Trigonal bipyramidal
(sp^3d hybridisation)



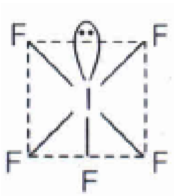
Square planar
(sp^3d^2 hybridisation)

18) 2

IF $_5$ The ground state and the excited state outer electronic configuration of iodine(Z=53) are represented below

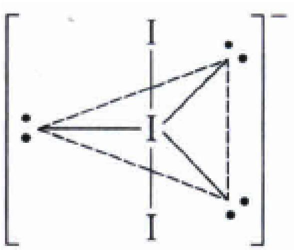


In IF $_5$,I is sp^3 d^2 hybridised therefore,shape of IF $_5$ is square pyramidal as it contains one lone pair of electrons



19) 2

The central I$_{\text{-atoms}}$ has the outer shell electronic configuration in the ground state as .It undergoes hybridisation.Out of the five hybrid orbitals,one is half-filled,one is empty and the remaining three are fully-filled.The half-filled orbital forms covalent bond with iodine atom.

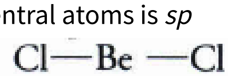


The triiodide ion

The empty orbital accepts electron pair from I$^-$ ion to form a coordinate bond.The remaining fully-filled orbitals occupy equatorial position.Thus,the geometry of three lone pairs and two bond pair is trigonal bipyramidal and the shape of I_3^- is linear as shown in the figure

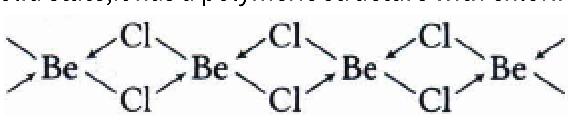
20) 2

In gaseous state at high temperature, BeCl$_2$ exists as linear molecule Cl-Be-Cl,,thus the hybridisation of the central atoms is *sp*



Structure of BeCl in gaseous state

In solid state,it has a polymeric structure with chlorine bridges as follows



Two Cl-atoms are listed to be atom by two coordination bonns and two by covalent bonds.For these bonds to be formed ,Be in the excited state with the configuration undergoes Sp^3 hybridisation.Two half-filled hybrid orbitals will form normal covalent bonds with two Cl-atoms.The other two Cl-atoms are coordinated to Be-atom.The other two Cl-atoms are coordinated be Be-atom by donating electron pairs into the empty hybrid orbitals.

Section-C

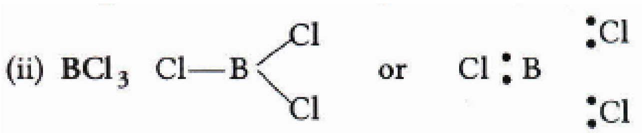
21) **5**

22) **5**

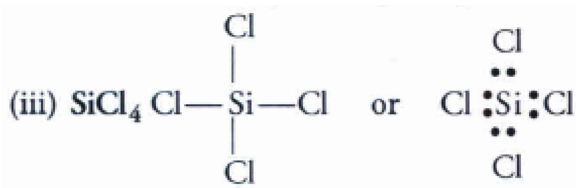
23)

According to VSEPR theory,the shape of a molecule depends upon the number shell electron pairs (bonded or non-bonded) around the central atom.Pairs of electrons in the valence shell repel each other.The order of their repulsion is as follows

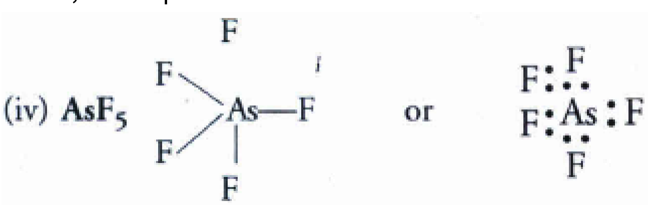
Cl,The central atom Be has only 2 valence electron which are bonded to Cl,so there are only 2 bond pairs and no lone pairs.It is of the type AB_2 and hence,the shape linear



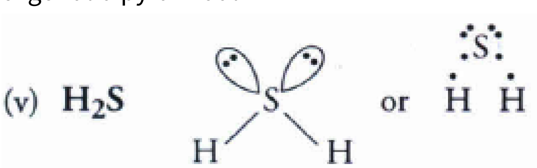
The central atom B has only 3 valence electron which are bonded with three CI atoms,so it contains only 3 bond pairs and no longer pair.It is of the type AB_3 and hence,the shape is trigonal plannar



Similarly,the central atom Si has only 4 bond pairs and no longer pair.It is of the type AB_4 and hence,the shape is tetrahedral

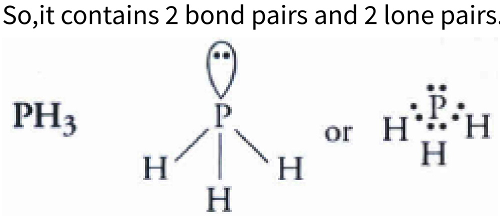


The central atom As has only 5 bond pairs and no lone pair.It is of the type AB_5 and hence,the shape is trigonal bipyramidal



The central atom S has 6 valence electrons.Out of these only two are used in bond formation with two H-atoms while four(two pairs) remains as non-bonding electrons(i.e lone pairs)

So,it contains 2 bond pairs and 2 lone pairs.It is of the type AB_2E_2 and hence,the shape is bent V-shaped



The central atom P has 5 valence electrons.Out of which three are utilised in bonding with H atoms and one pair remains as lone pair

So,it contains 3 bond pairs and one lone pair.It is of the type

AB_3 E and hence the shape is pyramidal

24)