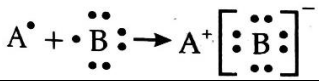
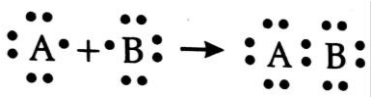
Long Answer Type Questions

Q. 1. Compare the properties of Ionic and Covalent compounds.

Ans. The main point of difference between ionic and covalent compounds are given as below:

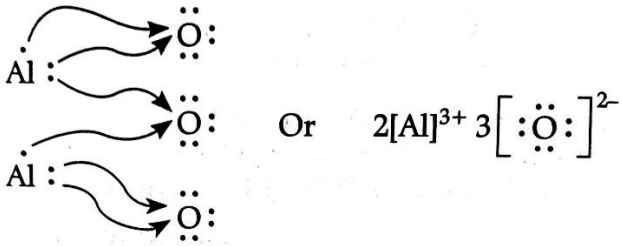
Ionic Compounds	Covalent Compounds
(i) They are formed as a result of complete transfer of electrons (gain or loss) from one atom to another. 	(i) They are formed by sharing of electrons between two atoms. 
(ii) These compounds are generally solids.	(ii) These compounds may be solids, liquids or gases.
(iii) They are made up ions with powerful electrostatic forces of attraction	(iii) They are made up of molecules held to-gather by weak van der Waals forces of attraction.
(iv) They have generally high melting and boiling points.	(iv) They have generally low melting and boiling points.
(v) They are generally soluble in polar sol vents like water and insoluble in organic Solvents.	(v) Covalent compounds are generally soluble is non-polar solvents such as benzene and insoluble in polar sol-vents
(vi) Ionic compounds conduct electricity in The molten or dissolved state.	(vi) Covalent compounds are generally bad conductors of electricity.
(vii) Ionic compounds are non-directional and are they do not show isomerism.	(vii) Covalent compounds rigid and directional. They show isomerism.
(viii) These compounds undergo ionic reactions which are very fast, almost instantaneous	(viii) These compounds undergo molecular reactions which are very slow.

Q. 2. Draw the Lewis dot structure of

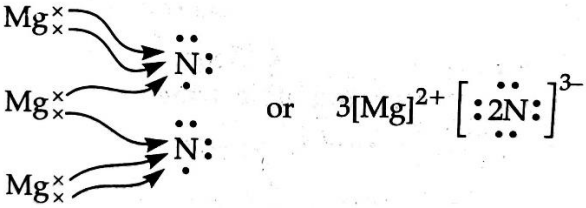
(a) Al_2O_3
(b) Mg_3N_2
(c) CCI_4
(d) NCI_3
(e) NCI_3 **[DDE, 2017-18]**

Ans.

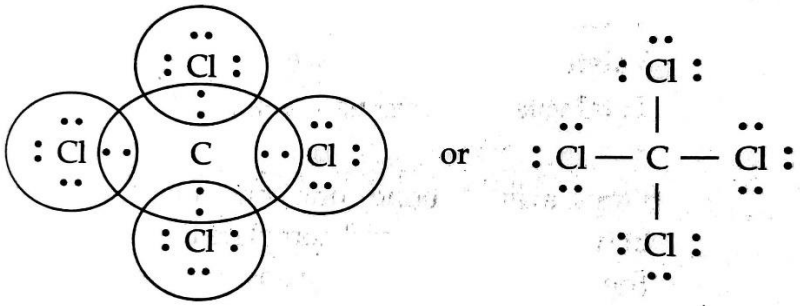
(a) Al_2O_3



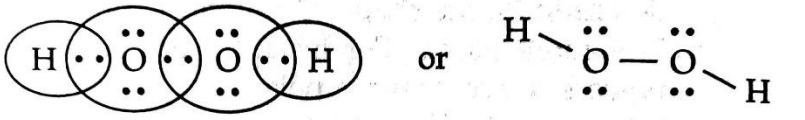
(b) Mg_3N_2



(c) CCl_4

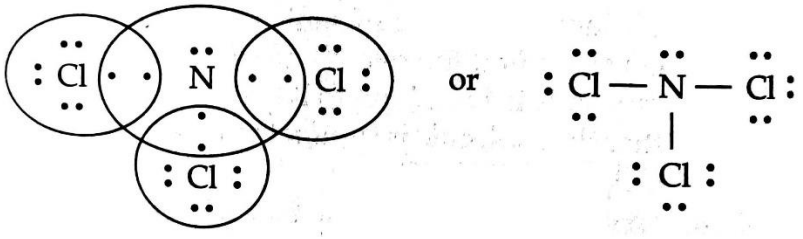


(d) H_2O_2



(1)

(e) NCl_3



Q. 3. What is resonance? What are the conditions for writing the resonating structures?

Ans. Resonance - When a molecule cannot be represented by a single structure but its characteristic properties can be described by two or more than two structures, then actual structure is said to be a resonance hybrid of these structures.

Conditions for Writing Resonating Structures:

The following are essential conditions for writing resonating structures

(i) The contributing structures should have same atomic positions.
(ii) These structures should have same number of unpaired electrons.
(iii) These structures should have nearly same energy.
(iv) These structures should be written such that negative charge is present on an electronegative atom and positive charge is present on an electropositive atom.
(v) In contributing structures, like charges should not reside on adjacent.

Q. 4. Who proposed VSEPR theory? What are the main postulates of Valence Shell Electron Pair Repulsion (VSEPR) theory?

Ans. Sidgwick and Powell (1940) proposed VSEPR theory on the basis of repulsive interaction of the electron pairs in the valence shell of the atoms, this theory was further developed by Nyholm and Gillespie (1950).

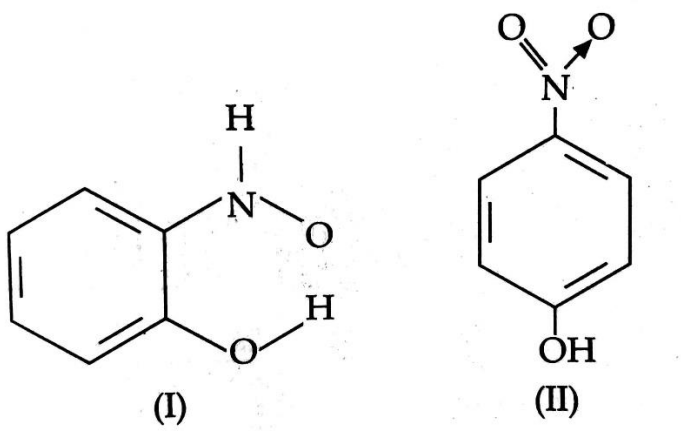
Main Postulates of VSEPR Theory-

(i) The shape of a molecule depends upon the number of valence shell electron pairs (bonded or non-bonded) around the central atom.
(ii) Electron pairs in the valence shell repel one another since their electron clouds are negatively charged.

(iii) These electron pairs tend to occupy such positions in space that minimize repulsion and so maximize distance between them.

(iv) The valence shell is taken as a sphere with the electron pairs localizing on the spherical surface at maximum distance from one another.
(v) A multiple bond is treated as if it is a single electron pair and the two or three electron pairs of a multiple bond are treated as a single super pair.
(vi) When two or more resonating structures can represent a molecule, the VSEPR model is applicable to any such structure.

Q. 5. (a) Structures of molecules of two compounds are given below:



(i) Which of the above two compounds will show higher boiling point?
(ii) Which of the above compounds will be more soluble in water?

(b) Give reason:

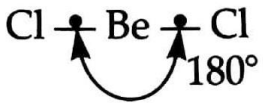
(i) Water molecule has bent structure whereas $BeCl_2$ has a linear structure.
(ii) Axial bonds of PCl_5 are longer than equatorial bonds.
(iii) BF_3 has zero dipole moment. [KVS, Mumbai Region, 2015-16]

Ans: (a) (i) Compound II (p-nitrophenol) has higher boiling point. In p-nitrophenol, molecular association takes place due to extensive hydrogen bonding between the molecules (intermolecular hydrogen bonding). Now due to the intermolecular hydrogen bonding, more energy needs to be supplied to vaporize the compound as there are extra bonds other than those present bonds that hold the molecule. Therefore, it has higher boiling point. In Compound I (o-nitrophenol), the intramolecular hydrogen bond results in the cyclisation of the molecule and prevents their association. Consequently, less energy needs to be supplied to vaporize the compound.

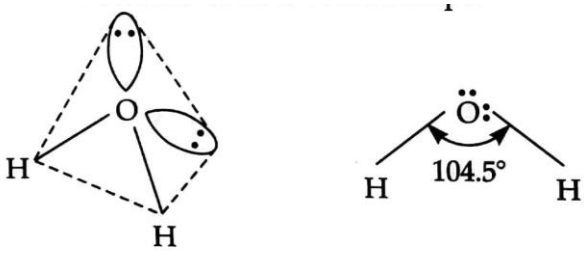
(ii) Compound II (p-nitrophenol) is more soluble in water than compound I (o-nitrophenol) because para nitrophenol is capable of forming hydrogen bonds with water.

(b) (i) Be (Atomic number 4) has a total of 4 electrons Its electronic configuration is $1s^2 2s^2$. It has two valence electrons and no lone pair of electrons. Each of the two electrons can take in forming bonds with chlorine atoms. Chemical bonds involve electrons and because all electrons have a negative charge, the two bonds between the be and CI will arrange themselves around the central atom (Be) so that the electrons in the bonds are as far apart as possible.

Thus, the molecule is linear with the chlorines on opposite sides of the be. This gives $BeCI_2$ & linear shape.



In case of water, oxygen has a total of 8 electrons, with electronic configuration $1s^2 2s^2 2p^4$. Oxygen has two electron pairs in the outermost shell, as well as two valence electrons available for bonding. The two single electrons can form bonds with two single electrons can form bonds with two hydrogen atoms and would like to again form a linear shape However, the two electrons pairs exert a strong repulsive force on the O−H bonds, distorting them into the bent shape of the water molecule. This shape maximizes the distance between all the electrons surrounding the central oxygen atom. That's why water molecule is bent in shape.



Shape (Angular)

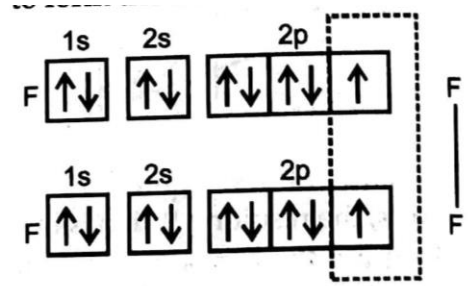
(½)

(ii) In PCI_5, there are three equatorial bonds and two axial bonds. The axial bonds are longer than equatorial bonds. The two axial bonds are at 90^0 to each other because the axial CI atoms suffer from more repulsion than the equatorial CI atoms. As a result, the axial Cl atoms tries to reside far away from the equatorial CI atoms and he
axial bonds are longer than equatorial bonds.

(iii) BF_3 has symmetrical structure in which the three B−F bonds are oniented at an angle of 120^0 to one another. Each B−F bond has a dipole moment with a partial negative charge on the fluorine. On adding together two of the bond moments in BF_3 the resultant moment is equal and opposite to the upper bond moment. These two moments cancel, and the molecule is nonpolar i.e. the dipole moment is zero.

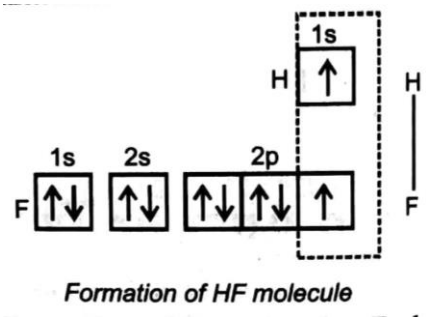
Q. 6. On the basis of orbital concept, explain the formation of following molecules F_2, HE, H_2O, O_2, N_20.

Ans. (i) Formation of F, molecule: Fluorine atom has one half-filled atomic orbital. Therefore, two atoms of fluorine combine to form the fluorine molecule.



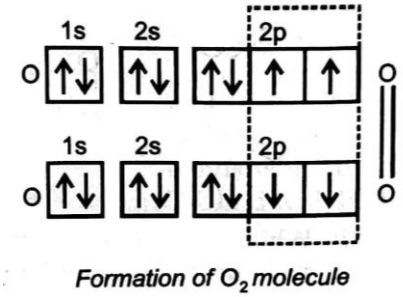
Formation of F_2 molecule

(ii) Formation of HF molecule: HF molecule is formed as a result of the combination of half-filled orbitals belonging to hydrogen and fluorine.



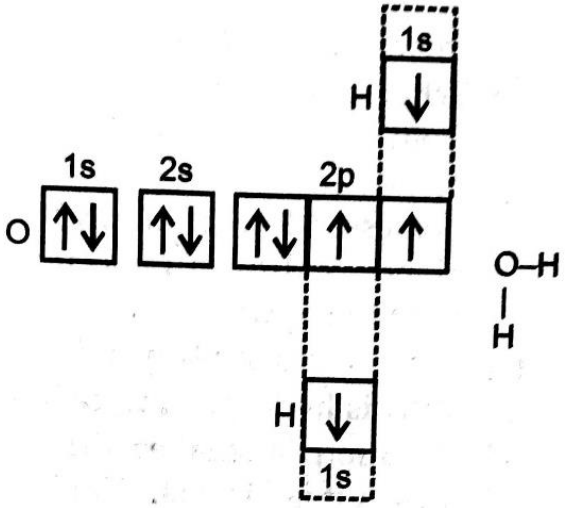
Formation of HF molecule

(iii) Formation of O_2 molecule: Each oxygen atom has two half-filled orbitals. Two such atoms will combine a molecule of O_2.



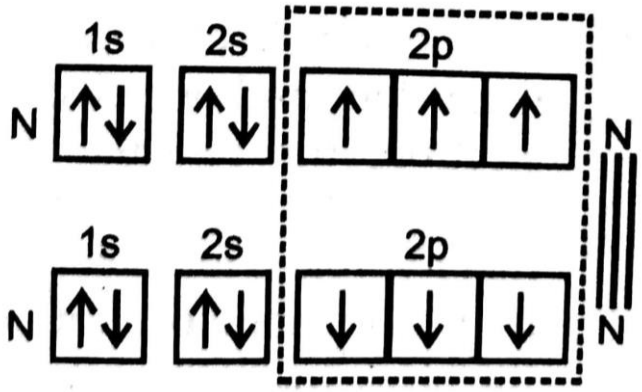
Formation of O_2 molecule

(iv) Formation of H_2O molecule: Oxygen has two half-filled orbitals. Thus, it combines with two hydrogen atoms.



Formation of H_2O molecule

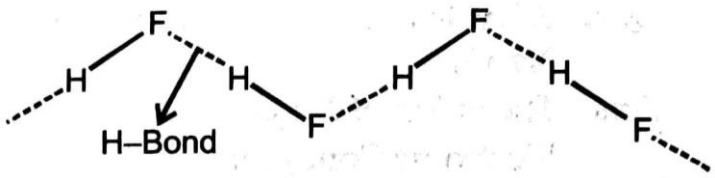
(v) Formation of N_2 molecule: Each nitrogen atom has 3 half-filled orbitals. Thus, two nitrogen atoms combine to form triple bond.



Formation of N_2 molecule

Q. 7. What is hydrogen bond? Describe the condition and causes of hydrogen bond formation, strength and types.

Ans. Definition: It is defined as the electrostatic force of attraction which exists between the covalently bonded hydrogen atom of one molecule and the electronegative atom other molecule.



Cause: An electrostatic force of attraction between hydrogen atom of one molecule and electronegative atom of second molecule.

Condition: (1) Hydrogen atom should be connected to highly electronegative atom say F, O or N.

(2) The electronegative atoms should be small in size.

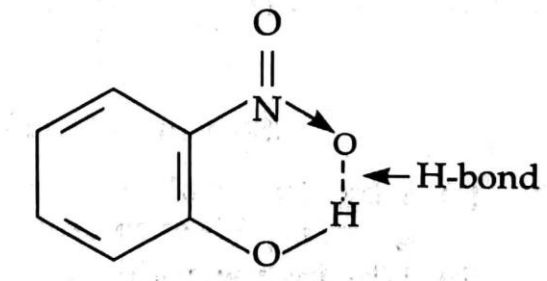
Strength: It is a very weak bond, weaker then ionic and covalent bond.

Types of H-Bonding: There are two types of hydrogen bounds.

(i) Intermolecular hydrogen bond: It is formed between two different molecules of the same or different compounds. For example, H-bond in case of HF, alcohol and water.

$H-F$…….. $H-F$……...$H-F$…… (Intermolecular) H-bond in HF molecule)

(ii) Intramolecular hydrogen bond: It is formed when hydrogen atom is in between the two highly electronegative (F, O, N) atoms present within the same molecule. For example, in *o*-nitrophenol the hydrogen is in between the two oxygen atoms.



(Intramolecular hydrogen bonding in o-nitrophenol molecule)