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Bond order ,Bond Length , Bond Enthalpy

BOND LENGTH

The bond length refers to the distance between the centers of the nuclei of two bonded atoms in an equilibrium position. The stronger the force of attraction in between the bonding atoms, the smaller is the length of the bond. However, the bigger the atom size, the longer the bond length. It is measured by spectroscopic, X-ray diffraction and electron diffraction technique. Each atom of the bonded pair contributes to the bond length. In case of a covalent bond, the contribution by each atom is the covalent radius of that atom.

Experimental Bond Lengths (in nanometers)

Molecule	Bond	Length
BCl_3	B—Cl	0.174
B_2H_6	B—H	0.132
Diamond	C—C	0.154
CH_4	C—H	0.110
CH_3I	C—H	0.110
	C—I	0.221
ClBr	Cl—Br	0.214
HF	H—F	0.092
H_2O	H—O	0.096
NH_3	N—H	0.101
OF_2	O—F	0.141
O_3	O—O	0.128
H_2SAlBr_3	S—Al	0.243
$(H_3Si)_2NN(SiH_3)_2$	Si—N	0.173

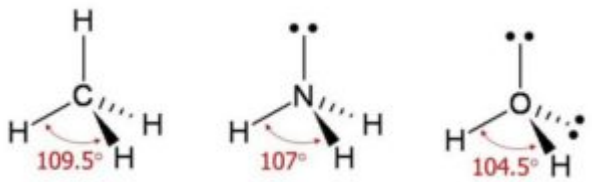
The certain factors upon which the bond length is dependent are –

- Bond Multiplicity: The bond length decreases with an increase in bond multiplicity.
- Size of an Atom: Bond length is directly proportional to the size of an atom. The bond length increases with the increase in the size of the atoms.

The stronger the force of attraction between the bonding atom, the smaller the bond length. However, the bigger the size of an atom, the longer will be the bond length. Also, it is to be noted that in the case of a covalent bond, the contribution by each atom is referred to as the covalent radius of that atom. Bond Angle

Bond angle refers to the angle between the two bonds i.e. the angle between two orbitals that contains a pair of bonding electron around the central atom in a complex molecule or an ion. This angle is usually measured in degrees, further calculated using the spectroscopic method.

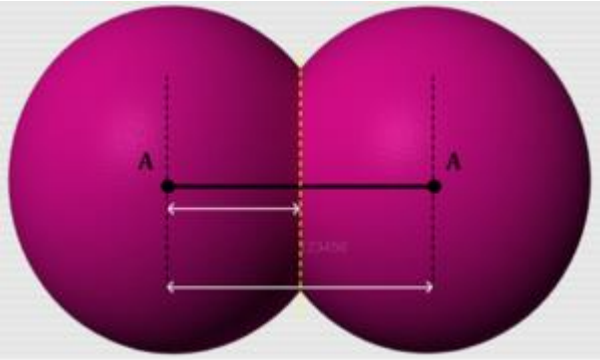
This gives a clear idea about the distribution of bonded electron pairs around the atoms and helps in determination of the shape of the molecules. It also gives an idea about the bonded electron pairs distribution around the atoms and determining the shape of the molecules.



Bond Enthalpy

The amount of energy which is needed in order to break one mole of the bond of a particular type between two atoms in a gaseous state is referred to as the Bond Enthalpies. Bond enthalpy is directly proportional to the strength of the bond between the molecules.

In case of polyatomic molecules, the two bonds of the same type can have different bond enthalpy. For e.g.: Two O-H bonds of water molecule have different bond enthalpy. Due to differences in bond enthalpy, polyatomic molecules have average bond enthalpy.



Factors affecting the bond Enthalpy:

- Atomic Size
- Electronegativity
- Extent of overlapping
- Bond Order

Bond Order

As per the Lewis description of covalent bonds, the bond order is the number of bonds that forms in between the two atoms in a molecule. The Isoelectronic molecules or ions have the same bond order.

For example, the two isoelectronicc molecules, F_2 and O_2^{2-} are isoelectronic molecules and so have the same bond order of 1. The greater the order of the bond, there is an increase in bond enthalpy and a decrease in the length of the bond.

The bond order in H_2 wherein one electron pair is shared is one, in O_2 where two electron pairs shared is two and in N_2 in which three electron pairs are shared is three.

- H – H Bond order = 1
- O = O Bond order = 2
- N ≡ N Bond order = 3
- C ≡ O Bond order = 3

Isoelectronic species have the same bond order. For Example, F_2, O_2^{2-} (18 electrons) have bond order 1 N_2, CO and NO^+ (14 electrons) have bond order = 3

Important Points Regarding the Bond Order

- The Isoelectronic species, those species that have the same number of electrons, have equal bond orders. Considering, for example, N_2, NO^+ and CO have a total of 14 electrons and all of them have the equal bond order of 3.
- The greater the order of the bond, the greater is the stability of molecules.
- The greater the order of the bond, the shorter is the length of the bond.

Solved Example For You

Question: Determine the bond order for nitrate (NO_3^-) ion.

Answer :

1. The Lewis structure of nitrate ion is:

2. Total number of bonds in the molecule = **4**
3. Total number of bond groups between individual atoms = **3**
4. Hence, the bond order is **4/3 = 1.33**