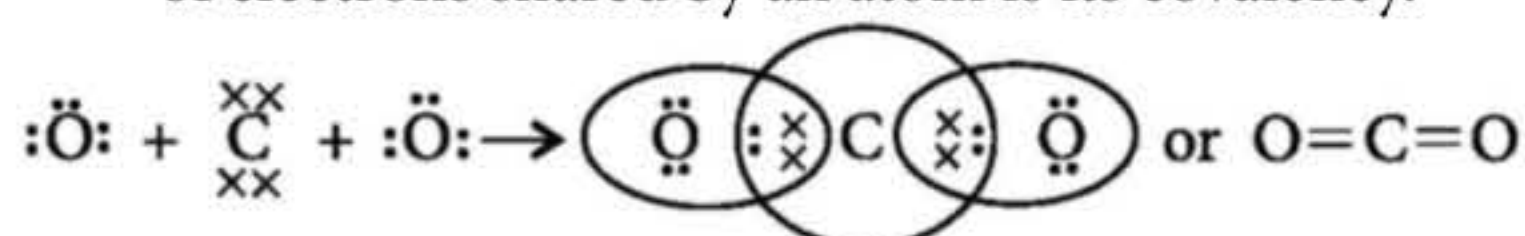


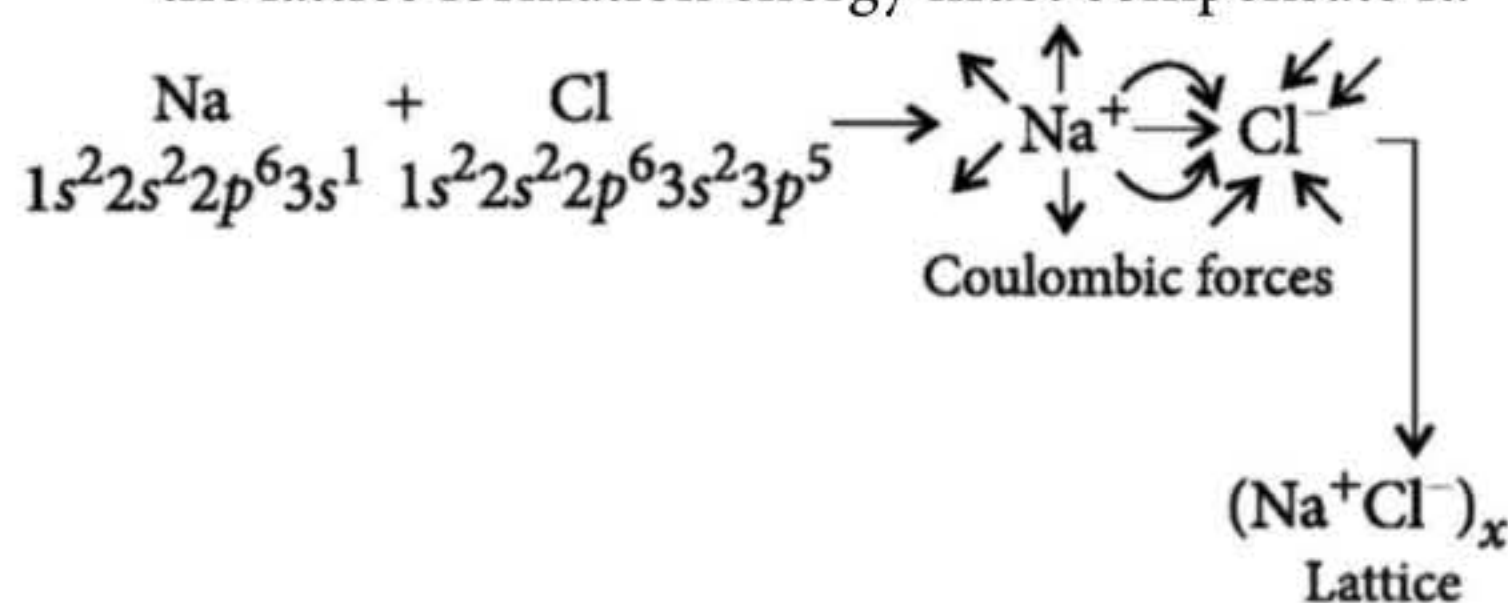
This specially designed column will help you to brush up your concepts by practicing questions. You can mail us your queries and doubts related to this topic at editor@mtg.in. The queries will be entertained by the author.*

CHEMICAL BONDING AND MOLECULAR STRUCTURE

- G.N. Lewis and Kossel separately gave the idea of octet formation by elements to attain stability like noble gases. Lewis gave the idea of valence shell acquiring shape of a cube on completing octet though not followed now.
- According to Lewis, covalent bond is formed by sharing of equal number of electrons between two electron deficient atoms. Later Langmuir used a hyphen (-) for a shared pair of electrons. Number of electrons shared by an atom is its covalency.

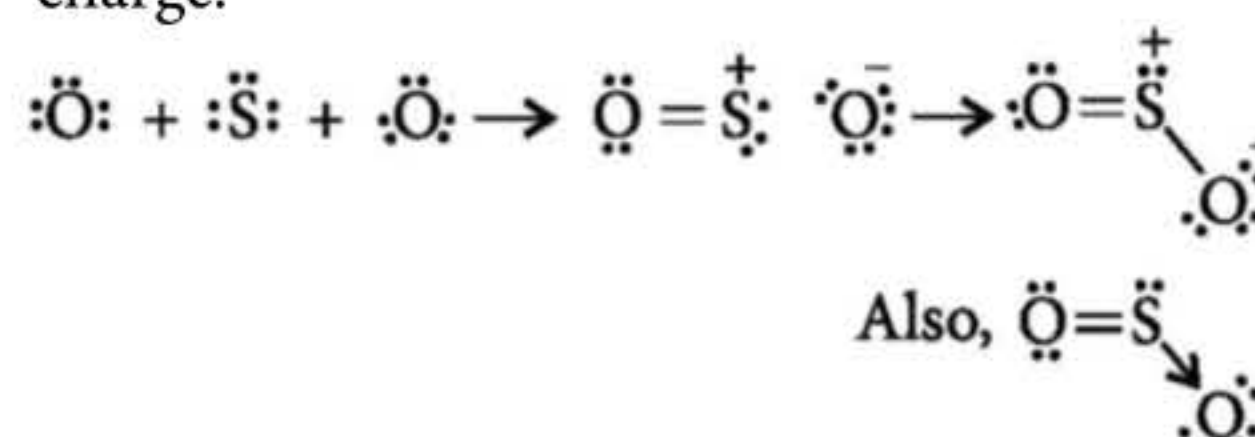


- According to Kossel, metals lose electrons while non-metals gain electrons to form cation and anion of charge corresponding to lost or gained electrons. These opposite ions join through coulombic or electrostatic forces and form ionic lattice. The number of electrons gained or lost by an atom is its electrovalency. Ionisation energy of metal should be low while electron gain enthalpy of non metal should be high to have net loss of energy. If not so, the lattice formation energy must compensate it.



- In coordinate bond, the shared pair of electrons comes from one atom called donor and the other

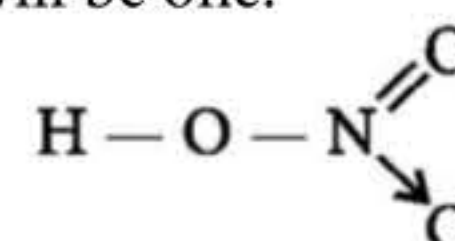
simply shares and is called acceptor. It causes formal charge.



Formal charge (F.C.) = Valence shell electrons of atom - unshared electrons - $\frac{1}{2}$ shared electrons.

$$\text{F.C. on right 'O'} = 6 - 6 - \frac{2}{2} = -1$$

- Bond order of a coordinate bond is 2 if the donor central atom can expand its valence shell and the acceptor atom can form a double bond otherwise bond order will be one.



N-atom cannot expand valence shell.

'→' bond has bond order one

- Polarity of a covalent bond depends upon the difference of electronegativities of bonded atoms :

Difference of E.N	% ionic character
2.0 - 3.2	Ionic bond
1.7 - 1.9	≈ 50% ionic character
0.1 - 1.6	Polar covalent bond.
- 100% ionic or 100% covalent bonds do not exist. Still, bond between two atoms of the same element is considered to be 100% covalent.
- Covalent character in electrovalent bond increases with increase of charge, increase of size of anion but decrease of size of cation. [Fajan rule]

*By R.C. Grover, having 45+ years of experience in teaching chemistry.

- Dipole moment (μ) of a polar bond = $(q \times d)$ Debye
1 Debye = 10^{-18} esu - cm = 3.33×10^{-3} C-m
% ionic character of bond

$$= \frac{\mu_{\text{observed}} \times 100}{\mu_{\text{for 100\% ionic character (theoretical)}}$$

A molecule is called polar if $\mu(\text{net}) \neq 0$

- Molecules or ions having equal number of atoms and electrons are called isosters, e.g., N_2 , CO and CN^- .
- For the same peripheral atom, along a period bond angle decreases but dipole moment increases. For the same peripheral atom down a group bond angle and dipole moment both decreases.
- Resonance is hypothetical phenomenon where two or more structures, having same locations of atoms and same number of lone pairs and lone electrons, represent the same molecule.

$$\text{Resonance stabilisation energy} = \Delta_{\text{reaction}} H_{\text{theoretical}} - \Delta_{\text{reaction}} H_{\text{exp}}$$

- The force of attraction between covalently bonded, positively behaving H-atom of a molecule with an electronegative atom (N, O, F) of the same molecule or (N, O, F) of different molecule is called hydrogen bond.
- Intermolecular hydrogen bond generally increases volume, boiling point and viscosity while decreases density. Intramolecular hydrogen bond decreases boiling point and makes compound steam volatile. Rigidity of silk, wool, sticky nature of honey, unexpected high b.pt. of water, etc., are due to hydrogen bonding.

MULTIPLE CHOICE QUESTIONS

- Which of the following is correct representation of sodium cation according to Lewis dot system?
(a) $\text{:}\ddot{\text{N}}\text{:}$ (b) $\text{:}\ddot{\text{N}}\text{:}^+$
(c) Na^+ (d) All of these
- Which of the following is the main valence of element having atomic number 17?
(a) 7 (b) -1 (c) 1 (d) -7
- According to Lewis when an atom complete its octet, the valence shell acquires
(a) circular shape (b) spherical shape
(c) cubic shape (d) star of 8 vertices
- Covalency of an element means
(a) the number of electrons gained by its atom
(b) the number of electrons lost by its atom
(c) the number of electrons shared by its atom
(d) the number of electrons donated by its atom.
- Which of the following is the correct dipole moment of HCl observed experimentally if the percentage ionic character is 17.48% and separation of H and Cl is 1.275×10^{-8} cm?
(a) 1.0 D (b) 1.3 D (c) 1.07 D (d) 2.3 D
- What is the formal charge on $\overset{\text{I}}{\text{O}}$ in ozone molecule
 $\text{:}\overset{\text{I}}{\text{O}}\text{:}\overset{\text{II}}{\text{O}}\text{:}\overset{\text{III}}{\text{O}}\text{:}$?
(a) Zero (b) +1 (c) -1 (d) -2
- Which of the following bond is the least ionic?
(a) F — F (b) O — F
(c) N — F (d) C — F
- Which of the following is the correct bond structure of molecule of nitric acid?
(a) $\text{H} - \text{O} - \text{N} \begin{matrix} \nearrow \text{O} \\ \searrow \text{O} \end{matrix}$ (b) $\text{H} - \text{O} - \text{N} \begin{matrix} \nearrow \text{O} \\ \searrow \text{O} \end{matrix}$
(c) $\text{H} - \text{O} - \text{N} \begin{matrix} \nearrow \text{O} \\ \searrow \text{O} \end{matrix}$ (d) $\text{H} - \overset{\ominus}{\text{O}} = \overset{\oplus}{\text{N}} \begin{matrix} \nearrow \text{O} \\ \searrow \text{O} \end{matrix}$
- Which of the following bond is the most ionic?
(a) O — F (b) N — F
(c) C — F (d) All equal
- What is the percentage ionic character of bond in LiH if the observed dipole moment is 1.964×10^{-29} C-m for the separation by 1.596 Å?
(a) 67.8% (b) 76.8%
(c) 68.7% (d) 86.7%
- What is the percentage covalent character in H — F molecule if μ observed is 1.78 D and bond distance is 0.92 Å?
(a) 56.96 % (b) 59.69%
(c) 65.90% (d) 99.56%
- Select the one having the smallest bond angle among the following.
(a) CH_4 (b) SiH_4 (c) NH_3 (d) H_2O
- Which of the following is not the canonical structure of acrolein, $\text{C}_3\text{H}_4\text{O}$?
(a) $\text{CH}_2 = \text{CH} - \text{CH} = \text{O}$
(b) $\text{CH}_2 = \text{CH} - \overset{\oplus}{\text{C}}\text{H} - \overset{\ominus}{\text{O}}$
(c) $\overset{\oplus}{\text{C}}\text{H}_2 - \text{CH} = \text{CH} - \overset{\ominus}{\text{O}}$
(d) $\overset{\delta^+}{\text{C}}\text{H}_2 = \text{CH} - \text{CH} = \overset{\delta^-}{\text{O}}$