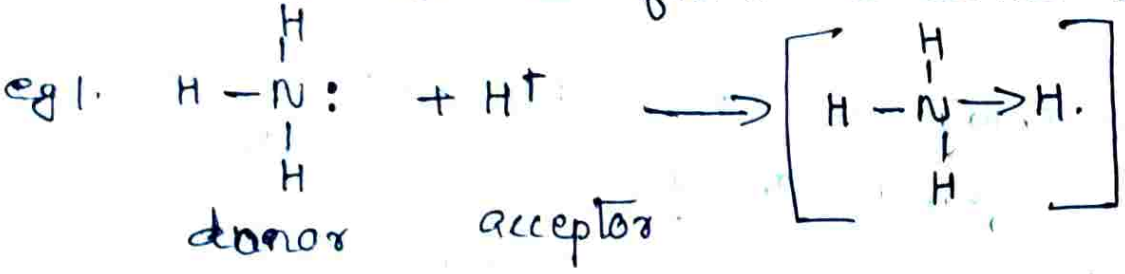
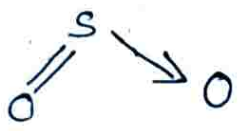
Co-ordinate Covalent bond

A co-ordinate covalent bond, also known as dative bond, dipolar bond or co-ordinate bond is a kind of two centre, two electron covalent bond in which the two electrons derive from the same atom.

eg 1. 

donor acceptor

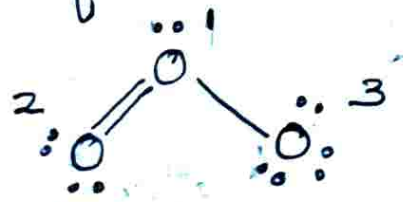
eg 2 SO_2 

In modern terminology, there is no distinction between a covalent bond and a coordinate bond because all electrons are alike irrespective of their source.

Formal charge

Formal charge = [No. of valence electrons in free atom] − [$\frac{1}{2}$ × No. of bonding $\bar{e}$s + No. of lone pair $\bar{e}$s in the atom]

eg. Structure of Ozone



Formal charge on O atom numbered as 1 $= 6 - \left(\frac{1}{2}6 + 2\right) = 1$

Formal charge on 'O' atom numbered as 2 $= 6 - \left(\frac{4}{2} + 4\right) = 0$

$= 6 - \left(\frac{2}{2} + 6\right) = -1$

Then charge on Ozone molecule = Sum of formal charges on all atoms.

Factors affecting the formation of ionic bond

1. Ionisation enthalpy — Lower the ionisation enthalpy, greater the ease of formation of cation.
2. Electron gain enthalpy ($\Delta_{eg}H$) — higher the electron gain enthalpy greater is the ease of formation of -ve ion (anion.)

$M_{(g)} \rightarrow M^{+}_{(g)} + \bar{e}$ [Ionisation enthalpy]

$X_{(g)} + \bar{e} \rightarrow \bar{X}_{(g)}$ [electron gain enthalpy]

$M^{+}_{(g)} + \bar{X}_{(g)} \rightarrow MX_{(s)}$.

3. Lattice enthalpy ($\Delta_{lattice}H$).

Higher the lattice enthalpy of a crystal, the greater will be the ease of its formation.

The energy released when one mole of a crystal is formed from its gaseous ions is called lattice enthalpy of that crystal.

$$Na^+(g) + Cl^-(g) \longrightarrow NaCl(crystal)$$

$$\Delta_{lattice}H = -788 KJ\,mol^{-1}$$

Lattice enthalpy depends upon the following factors.

1. Charge on the ion – Higher the charge on the ions, greater is the force of attraction and hence higher is the lattice enthalpy.
2. Size of ion – Smaller the size of the ion, greater will be the inter-ionic attraction, larger will be the magnitude of lattice enthalpy

Bond Parameters

Bond length – The internuclear distance between two bonded atoms is called bond length.

Bond angle – The angle between the orbitals containing bonding electron pairs around the central atom in a molecule or ion is called bond angle.

H–Ö–H angle in water is 104.5°.

Bond enthalpy: The enthalpy change involving the breaking of one mole bonds of a particular type in a gaseous molecule

$H_2(g) \longrightarrow 2H(g) \quad \Delta H = +433.4\ KJ\ mol^{-1}$.

ie the bond enthalpy of H–H bond is $433.4\ KJ\ mol^{-1}$.

In poly atomic molecule, the average of the bond enthalpies of various bonds are taken.

eg $H_2O(g) \longrightarrow H(g) + OH(g) \quad \Delta H_1 = +502\ KJ\ mol^{-1}$.

$OH(g) \longrightarrow O(g) + H(g) \quad \Delta H_2 = +427\ KJ\ mol^{-1}$.

Average bond enthalpy of O–H bond $= \frac{502+427}{2}$

$= 464.5\ KJ\ mol^{-1}$

Bond Order: Number of bond formed between two atoms

Bond Order of $Cl_2 = 1$. (Cl–Cl)

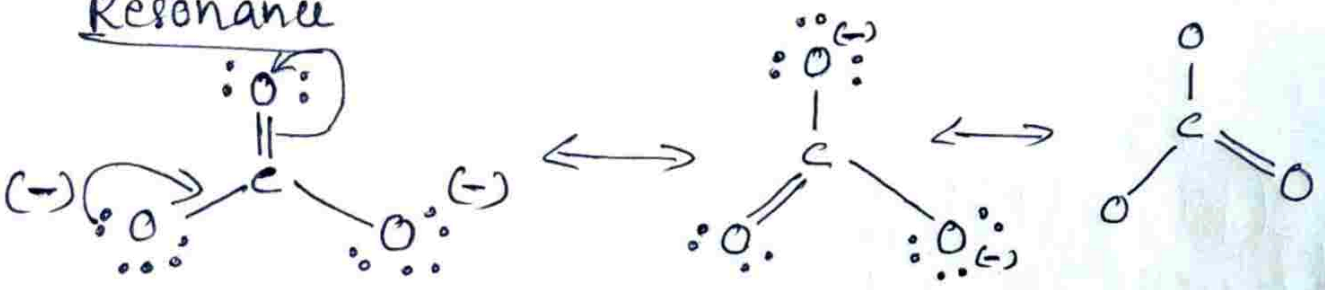
" $O_2 = 2$ (O=O)

$N_2 = 3$ (N≡N)

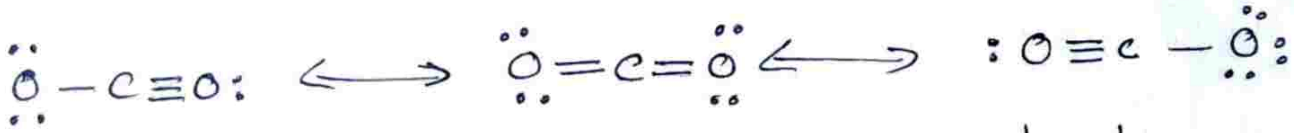
Resonance structure

Resonance: If a molecule can be assigned, two or more structural formulae

each of which can explain most of but not all the properties of the compound and the actual structure lies somewhere between the various possible conventional structures, the phenomenon is called Resonance



CO_3^{2-} ion



Resonance in CO_2 molecule.

Resonance energy

Resonance stabilises a molecule. The energy of the actual molecule will be less than the energy of the stablest of the contributing structures. The contributing structures are known as canonical forms.

The difference in energy between the actual molecule & the stablest canonical form is called resonance energy