Notes on Dipole moment

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❑ The positive and negative ends of a polar bond give it a dipole.

❑ When two atoms of different electronegativities are bonded to each other by a covalent bond, two electrical poles, positive and negative develop at the two ends of the bond; the more electronegative atom becomes the negative pole while the less electronegative atom becomes the positive pole and the bond is said to be polar.

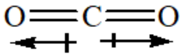
❑ The dipole moment of a bond is defined as the magnitude of the charge (e) on the atom (either the partial positive charge or the partial negative charge because they have the same magnitude) times the distance between the two charges (d).

❑ A dipole moment is measured in a unit called debye (D).

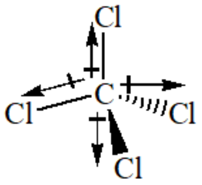
❑ Dipole moment = μ = e X d, e = 4.80 X 10^{-10} electrostatic unit (esu) and the distance between charges in a polar bond is on the order of 10^{-8} cm. So the product of charge and distance is on the order of 10^{-18} esu. cm which is stated as debye (D).

❑ In a molecule with only one covalent bond, the dipole moment of the molecule is equal to the dipole moment of the bond.

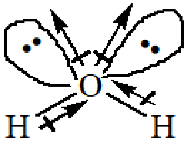
❑ The dipole moment of a molecule with more than one covalent bond depends on the geometry of the molecule as well as on the dipole moments of all the bonds in a molecule because both the magnitude and direction of the individual bond dipole moments are used to determine the overall dipole moment of the molecule.



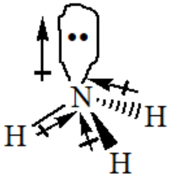
Carbon dioxide
$\mu = 0$ D



Carbon tetrachloride
$\mu = 0$ D



Water
$\mu = 1.85$ D

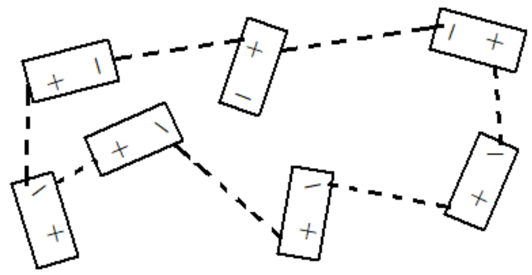


Ammonia
$\mu = 1.47$ D

Table 1: Some bond moments

Bond	Dipole moment μ in D	Bond	Dipole moment μ in D	Bond	Dipole moment μ in D
H — C (sp^3)	0.31	C — Br	1.48	C — F	1.51
H — C (sp^2)	0.63	C — I	1.29	C — Cl	1.56
H — C (sp)	1.05	C — N	0.40	C(sp^3) — C(sp^3)	0.68
H — N	1.31	C = N	0.90	C (sp^3)— C(sp)	1.48
H — O	1.53	C≡ N	3.60	C(sp^2) — C(sp)	1.15
H — F	1.98	C — O	0.86	N^+ — O^-	3.20
H — Cl	1.03				

❑ **Molecules with dipole moments are attracted to one another because they can align themselves in such a way that the positive end of one dipole is adjacent to the negative end of another dipole. These electrostatic attractive forces are called dipole-dipole interactions.**



❑ **Bond dipoles are intimately associated with physical and chemical properties of a molecule and these determine the kind of reaction that can take place in a bond.**