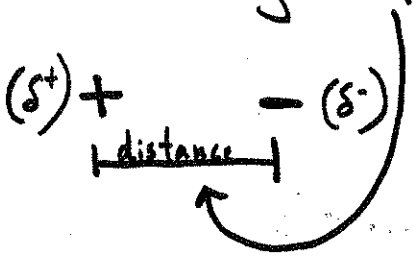
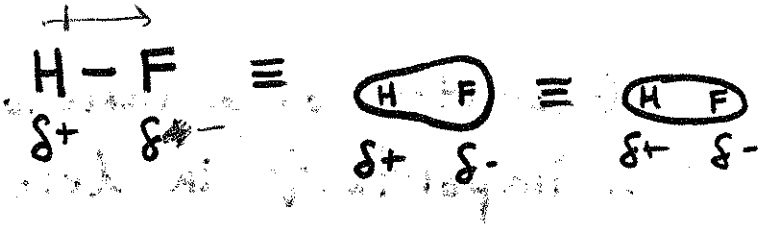
Dipole

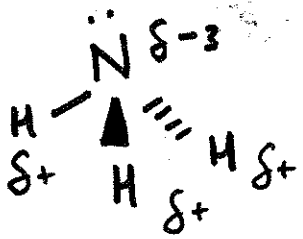
Charge separation within a bond



How to Represent

Molecules:

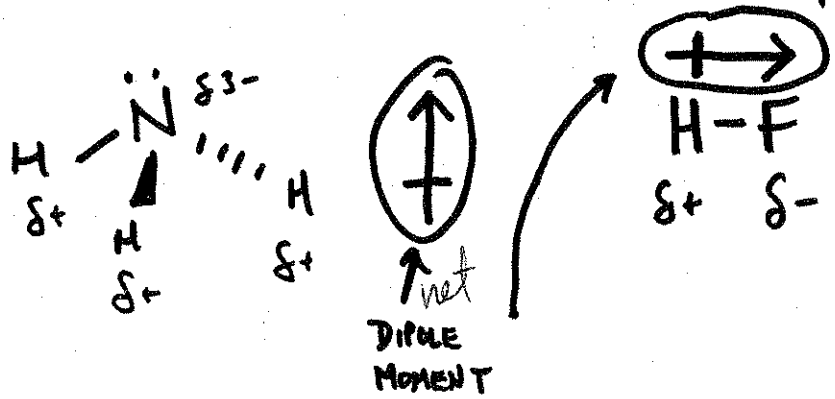


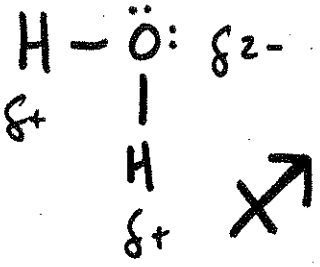


Why does a dipole arise?
Differences in electronegativity between two atoms in a bond.

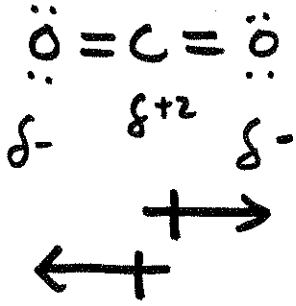
Dipole Moment of a Molecule

The vector sum of all the dipoles in a molecule





polar, water has a dipole moment

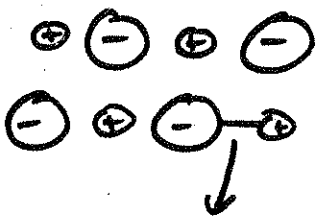


non-polar, carbon dioxide's dipole moments cancel out

Geometry of a molecule is important in determining the polarity of a molecule.

Dipoles in Chemical Bonding

ionic

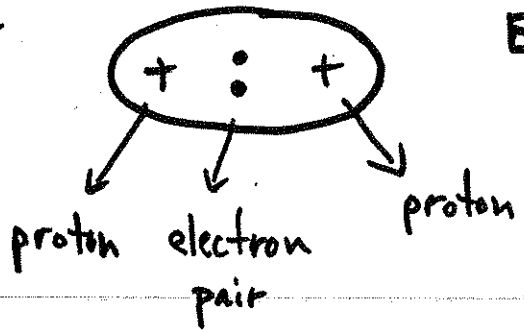


coulombic force

$$\frac{\delta+\ \delta-}{r^2} = F$$

400-4000 $\frac{kJ}{mol}$

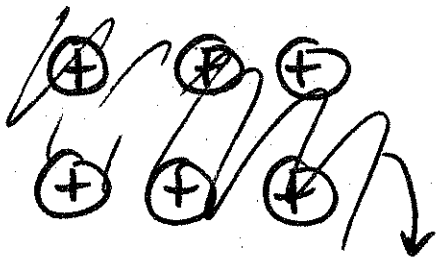
Covalent



E_p repulsion = E_p attraction

150-1100 $\frac{kJ}{mol}$

Metallic



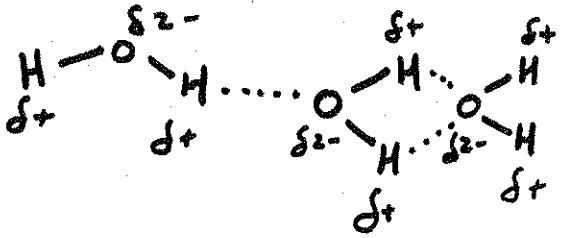
Cations with delocalized e-

75-1000 $\frac{kJ}{mol}$

Intermolecular Forces

Ion-Dipole $Na^{\oplus}$ $Cl-H$ (δ− δ+) 40-600 kJ/mol

Hydrogen Bond (H bonded to O, N, or F can bond with other molecules)



10-40 kJ/mole

Dipole-Dipole $\overset{\delta+}{H}-\overset{\delta-}{Cl}$ $\overset{\delta+}{H}-\overset{\delta-}{Cl}$ 5-25 kJ/mol

Dipole-Induced Dipole $\overset{\delta+}{H}-\overset{\delta-}{F}$ $F-F \rightarrow$ $\overset{\delta+}{H}-\overset{\delta-}{F}$ $\overset{\delta+}{F}-\overset{\delta-}{F}$ 2-10 kJ/mol

Ion-Induced Dipole $Fe^{+2} + \ddot{O}=\ddot{O} \rightarrow Fe^{+2}$ $\overset{\delta-}{\ddot{O}}=\overset{\delta+}{\ddot{O}}$ 3-15 kJ/mol

Dispersion (London) (~~Van der Waals~~)

$I-I \rightarrow \overset{\delta+}{I}-\overset{\delta-}{I} \xrightarrow{I-I} \overset{\delta+}{I}-\overset{\delta-}{I}$ $\overset{\delta+}{I}-\overset{\delta-}{I}$

non-polar — momentary dipole — induced momentary dipole

0.5-40 kJ/mol

↳ ∝ MW ∝ # of polarizable electrons

BP (He 4K, Ne 27K, Ar 87K, Kr 121K)

Polarizability: the ease w/which the electron cloud of an atom or molecule can be distorted.

Trend: Elements become less polarizable going across the periodic table and more going down!