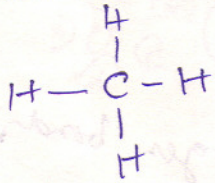
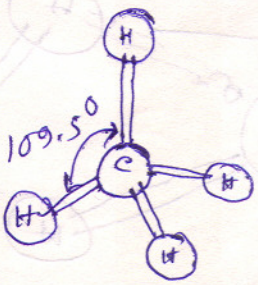
Chemical Foundations.

(#) Each atom has a defined no. & geometry of covalent bonds.

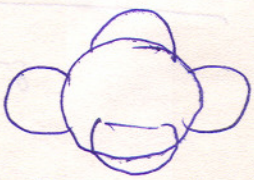
Atom & Outer Electrons	Usual no. of covalent bonds.	Bond Geometry.
H	1	H
O	2	
S	2, 4 or 6	
N	3 or 4	
P	5	
C	4	

(a) Methane



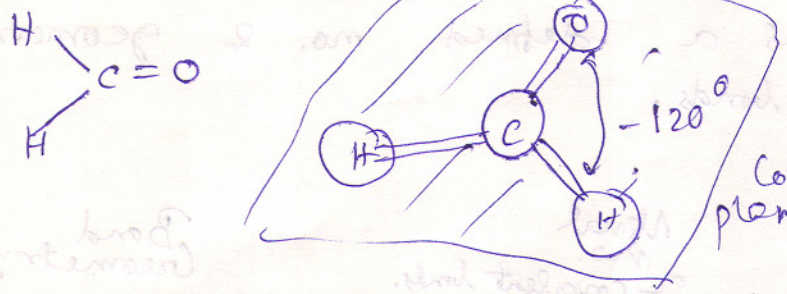


Ball & Stick model.



Space Filling Model

Formaldehyde. (CH_2O)

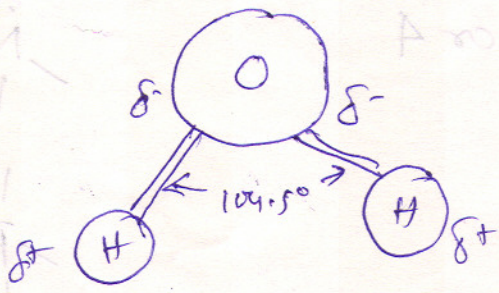


(#) Electrons are shared unequally in polar covalent bonds.

Electronegativity: The extent of an atom's ability to attract an electron.

If two atoms differ in their electronegativities, the bond between them is said to be polar.

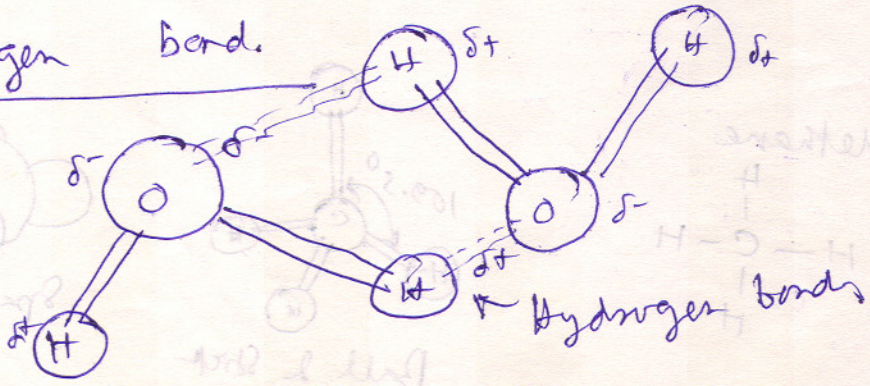
e.g.



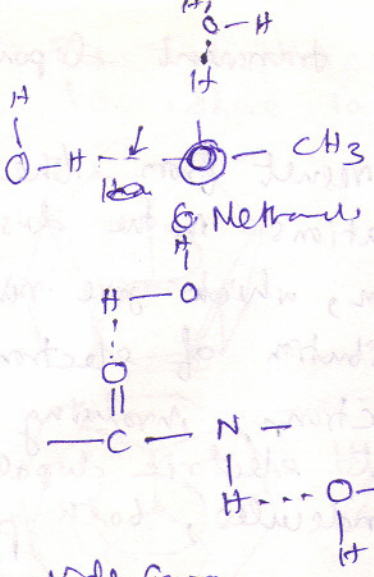
Polar

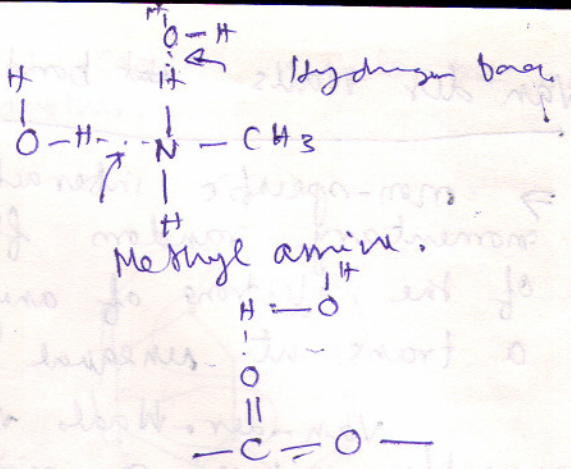
C–C, C–H non-polar.

(#) Hydrogen bond.



Hydroxyle & amide groups also for hydrogen bonds





Peptide group

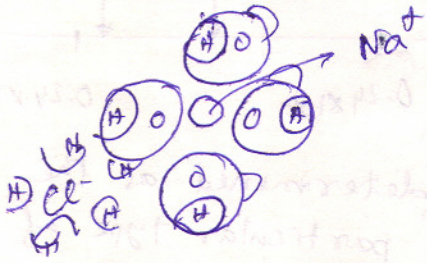
Ester group.

The solubility of uncharged substances in an aqueous ~~so~~ environment depends largely on their ability to form hydrogen bond with water e.g. -OH group in CH_3OH & $-NH_2$ grp in CH_3NH_2.

(#) Ionic bonds.

Attraction between cation (+) and anion (-).

The bonding electron is completely transformed from cation to anion e.g. $Na^+ \rightarrow Cl^-$



(#) Van der Walls ~~bnd~~ bond for transient dipoles.

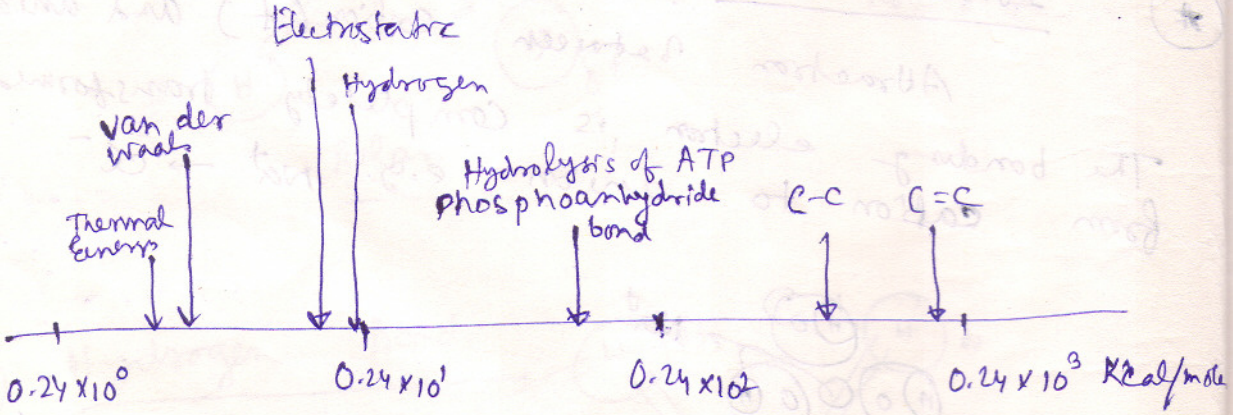
⇒ non-specific interactions result from the momentary random fluctuations in the distribution of the electrons of any atom, which give rise to a transient unequal distribution of electrons.

Van-der-Waals interactions, involving either transiently induced or permanent electric dipoles, occur in all types of molecules, both polar & nonpolar.

~~Imp~~ Responsible for particularly cohesion between nonpolar liquids & solids, such as heptane (C_7H_{16}) that cannot form hydrogen bonds or ionic interactions with other molecules.

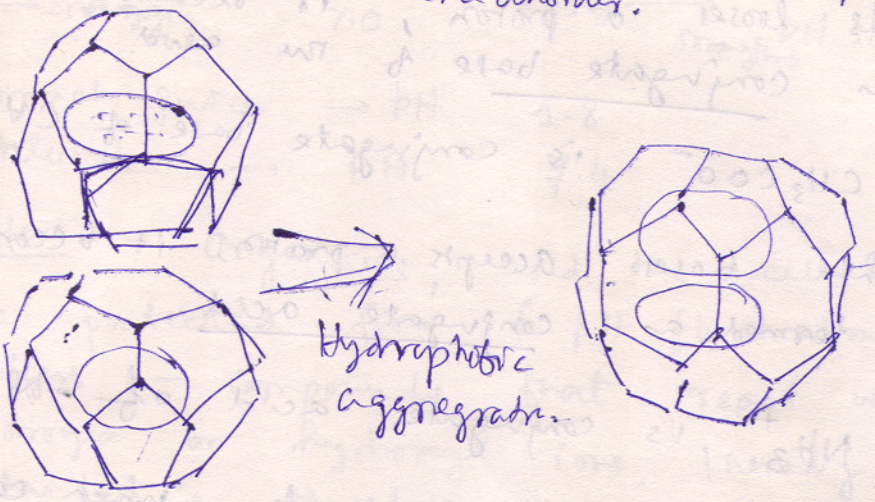
(#)

Covalent bonds are much stronger and more stable than noncovalent interactions.



Bond energies are determined as the energy required to break a particular type of linkage. Covalent bonds are one to two powers of 10 stronger than non-covalent interactions. The latter are somewhat greater than the thermal energy of the environment at normal room temp. (25°C).

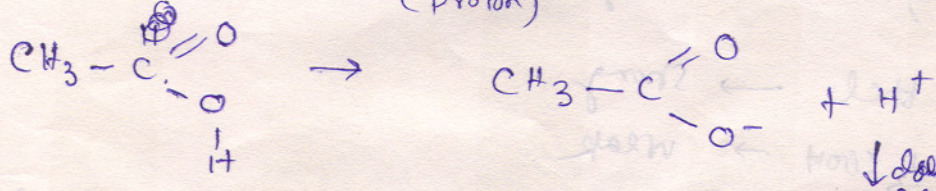
(#) The hydrophobic effect causes nonpolar ~~not~~ molecules to adhere to one another.



(#) Polar molecules are hydrophilic. (Soluble in water by formation of hydrogen bond).

(#) Acids, bases and buffers.

Acids: A molecule that is capable of releasing (donating) a hydrogen ion is termed as acid.
(proton)



↓ does not remain in free state absorbed in other molecules (bases)

e.g. $H^+ + H_2O \rightarrow H_3O^+$

or, $H^+ + OH^- \rightarrow H_2O$

or, $H^+ + -NH_2 \rightarrow -NH_3^+$

Bases:

Any molecule that is capable of accepting a proton is defined as a "base".

e.g. H_2O, NH_2,

Acids and bases exist in pairs, or couples. When acids looses a proton, it becomes a base termed as conjugate base of the acid.

e.g. CH_3COO^- is conjugate base of $CH_3C(=O)OH$

Similarly, when bases accepts a proton, it becomes an acid, termed as conjugate acid.

e.g. $-NH_3^+$ is conjugate acid of $-NH_2$ group

Water is amphoteric molecule which can act as both base & acid.

$$H_3O^+ \rightleftharpoons H^+ + H_2O \rightleftharpoons OH^- + H^+$$

acid (H_3O^+) — base (H_2O) — base (H_2O) — acid (H_2O)

amphoteric
↳ another example: amino acids.

The more readily the proton is lost, the less strong the attraction of a conjugate base for its proton, the stronger the acid.

→ HCl → strong

CH_3COOH → weak

The acidity of a solution is measured by the concentration of hydrogen ions and is expressed in terms of pH.

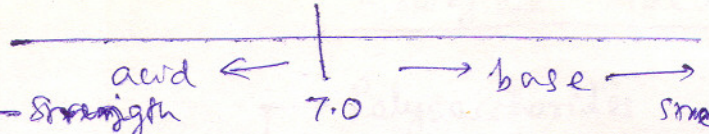
$$pH = -\log [H^+]$$

$[H^+]$ = molar concentration of proton (mole/litre).

At 25°C, $H_2O \rightleftharpoons H^+ + OH^-$

10^{-7} M, 10^{-7} M

∴ pH of H_2O = 7



Stomach juice → pH 1.8

blood → pH 7.4

Buffers: Organisms, and the cells they comprise, are protected from pH fluctuations by buffers – compounds that react with free hydrogen or hydroxyl ions, thereby resisting changes in pH. Buffer solutions usually contains a weak acid together with its conjugate base.

The blood is buffered by carbonic acid & bicarbonate ions, maintaining pH at 7.4.

$$HCO_3^- + H^+ \rightleftharpoons H_2CO_3$$

Bicarbonate ion — carbonic acid.