Chemical Bonds

A Chemical bond is a force of attraction holding the atoms or ions together.

- Elements tend to enter into chemical reaction to gain stability
- This is satisfied by completing the octet
- This may be done in different ways leading to the formation of the different types of bonds
- A decrease in energy is usually accompanied by an increase in stability
  (There are exceptions to this think entropy then!!!!!)

The different kinds of Bonds are

- Ionic Bonds
- Covalent Bond
- Coordinate Bonds
- Metallic Bonds

Ionic Bonds:

- A bond formed between two ions – Cation and Anion
- The force of attraction is electrostatic in nature
- The bonds are very strong
- The molecules do not have a definite shape but they have a specific crystal structure

Conditions necessary for the formation of an ionic bond:

- Atoms forming positive (Cat) ions should have: (Usually Metals)
  - Low Ionisation Energy
  - Low electron affinity
  - Low electro negativity
  - High Lattice Energy

- Atoms forming negative (An) ions should have (Usually Non-Metals)
  - High Electron affinity
  - High Electro negativity
  - High ionisation energy
  - High Lattice energy

Covalent Bonds:

Conditions necessary for the formation of covalent bonds:

- A bond formed by mutual sharing of electrons
- Formed between two or more non-metals – difference in electro negativity should not be high.
- A single bond represents 2 electrons
- They satisfy the octet rule by sharing of electrons
- These molecules have a definite shape

Coordinate Covalent Bonds or Dative Bonds:

A coordinate bond is similar to a covalent bond after formation only the method of formation and representation is different.

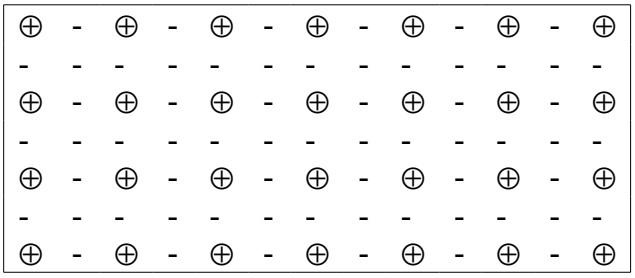
Conditions necessary for the formation of a Coordinate bond:

- The two electrons (lone pair) required for the formation of a bond comes from a single atom
- The second atom provides the space (vacant orbital) for accommodating the electrons
- The bond is represented using an arrow. The head of the arrow pointing towards the atom providing the orbital
- Once the bond is formed it behaves like a covalent bond

Metallic Bonds:

Seen in metals:

The positively charged metal kernels are supposed to be distributed in a sea of electrons. Cohesive forces hold the metals kernels together. The electrons are free to move around in the metal lattice. Metallic bonds are non-directional hence malleable and ductile.



Pure covalent bond:

If a bond is formed between two similar kind of atoms then the bond is a perfect covalent bond.

Polar Covalent Bonds:

A covalent bond formed between atoms with significantly different electronegativities

How to distinguish between a polar covalent and an ionic bond?

If the difference in electronegativities between the two atoms forming the bond is = or > 1.7 the bond is considered to be an ionic bond.

How to Write Lewis Structures

Step 1:	Decide which atoms are bonded.
Step 2:	Count all valence electrons
Step 3:	Place two electrons in each bond.
Step 4:	Complete the octets of the atoms attached to the central atom by adding e-'s in pairs.
Step 5:	Place any remaining electrons on the central atom in pairs.
Step 6:	If the central atom does not have an octet, form double bonds. If necessary form triple bonds.

1. What is the probable skeletal structure of sulphuric acid, H_2SO_4?
2. Predict reasonable skeletal structures for NO_3^-, $HClO_3$ and H_3PO_4.
3. How many dots, representing valence electrons, must appear in the Lewis structures of SO_3, NO_3^-, and NH_4^+?
4. How many dots should appear in the Lewis structures of SO_2, PO_4^{3-}, and NO^+?
5. Write the Lewis structure for SO_4^{2-}
6. What is the Lewis structure for the ClO_2^- ion?
7. What is the Lewis structure for the carbon monoxide molecule, CO?
8. What is the Lewis structure for SF_4?
9. Draw Lewis structures for OF_2, ClF_3 and $HClO_4$

SHAPES OF MOLECULES:

Molecule	'VSEPR' Shape	Bond Angle	Example	Comment
HX	Linear	-	H—Cl, H—F	Regular
AX_2	Linear	180^o	BeF_2, CO_2	sp hybridization
AX_3	Trigonal	120^o	BF_3	sp^2 Regular
AX_3E	Pyramidal	107^o	$:NH_3$	sp^3 (Distorted Tetrahedra)
AX_2E_2	V-Shaped Or Bent	104.5^o	$H_2ö:$	sp^3 (Distorted Tetrahedra)
AX_4	Tetrahedral	109^o 28'	CH_4	Regular Tetrahedra
AX_5	Trigonal bipyramidal	120^o and 90^o	PCl_5	sp^3d
AX_6	Octahedral	90^o	SF_6	sp^3d^2

VSEPRTheory:
Lone pair – Lone pair repulsion is > lone pair – bond pair repulsion is > bond pair – bond pair repulsion.

DIPOLE:
A polar bond leads to the formation of a dipole. One end of the molecule will be positively charged and the other is negatively charged the charge being small is referred to as delta positive δ^+ or delta negative δ^-. The magnitude of the charge depends on the difference in electronegativity. Higher the difference in electronegativity the greater is the polarity of the molecule.
For molecules with more than two bonds the resultant of the vector forces are used to calculate the resultant dipole moment or effective dipole moment.

FORCES OF ATTRACTION

↓ INTRAmolecular forces of attraction
(Inside the molecule)
1. Covalent Bonds
2. Ionic Bonds

↓ INTERmolecular forces of attraction
(Between molecules)
1. Hydrogen Bonds – Strongest Force
2. Dipole – Dipole attraction
3. London's dispersion or Vanderwaals force – Weakest force

HYDROGEN BONDS:
It is not a regular bond! It is an intermolecular force of attraction only

Note: Only hydrogen's attached to N, O and F shows this property.

DEFINITION:
The attractive force which binds hydrogen atom of one molecule with electronegative atom (N,O or F) of another molecule is known as hydrogen bond or hydrogen bonding. It is the strongest intermolecular force.

DIPOLE – DIPOLE ATTRACTION:
These are present in polar molecules (determine polarity of molecules first using shapes of molecules) These forces are intermediate between H-bonding and Dispersion or Vanderwaals force.

DISPERSION OR VANDERWAALS FORCE:
These forces formed due to temporary polarisation of molecules depends on the size of the molecule. The larger the molecule the greater the force of attraction between the molecules. These are the weakest force of attraction between non-polar molecules. All molecules possess this force of attraction
Problems based on Intermolecular forces:

BOILING POINT:
It is defined at the temperature at which the vapour pressure of a liquid equals the atmospheric pressure.

To boil a liquid heat energy is needed
The heat energy is used to overcome the intermolecular forces of attraction like H-bonding, Dipole – Dipole attraction and Dispersion or Vanderwaals force.
If the intermolecular force of attraction is high the Boiling Point of the liquid would be high.
So if we identify which molecule has a higher intermolecular force of attraction between them we could predict the molecule that has a higher boiling point.

Solve the following problems by determining the type of intermolecular forces present in the molecule.

1. Predict the type of intermolecular forces that are present in the different atoms and molecules Xenon, Carbondioxide or CO_2, Chloromethane or CH_3Cl, Ammonia or NH_3
2. Which among the following would have a higher boiling point H_2, Ne or CO_2
3. Which would have a higher boining point Pentane C_5H_{12} or Nonane C_9H_{20}
4. Which has a higher boiling point NH_3, NCl_3 or NF_3 – Give reasons for your answer
5. Which has a higher boiling point H_2O or H_2S – Give reasons for your answer?
6. Which has a higher boiling point CH_3Cl or CH_3Br – Give reasons?

HYDROGEN BONDS:
It is not a regular bond! It is an intermolecular force of attraction only

Note: Only hydrogen's attached to N, O and F shows this property.

DEFINITION:
The attractive force which binds hydrogen atom of one molecule with electronegative atom (N,O or F) of another molecule is known as hydrogen bond or hydrogen bonding.