Covalent Bond

Definition: strong electrostatic attraction between positive nuclei of 2 atoms and bonding electrons shared between them

Properties: bond is formed by the sharing of electrons. electronegativity difference between both atoms in the covalent compound is small (<1.6)

formation of a covalent bond involves the overlapping of valence orbitals of the atoms. different ways of overlapping results in different types of bonds (namely sigma and pi bond)

head on overlap of s orbitals/p orbitals/ s and p orbital results in the formation of a **sigma bond**. electrons are concentrated **between the nuclei of the bonding atoms**	when 2 **p orbitals** that are **parallel** to each other **overlap sideways** , this forms a **pi bond**. electrons are concentrated **above and below the plane of the nuclei of the bonding atoms**

pi bond is **weaker** than a sigma bond/ in all multiple bonds, **only 1 bond** will be a sigma bond and the rest will be pi bonds

the relative weakness of pi bonds compared to sigma bonds is due to their lesser extent of overlap between atomic orbitals, more diffuse electron density, and increased exposure to the surrounding environment.

Dative Covalent Bond

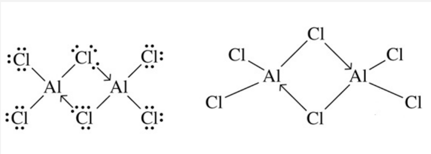
bond formed when only one atom contributes the two bonding electrons

involves 1 electron donor (have at least an extra lone pair of electrons to donate) and 1 electron acceptor (have at least an empty orbital to accept the electron pair

represented as A:->B(A donated the electrons and B accepted them)

common example: dimerisation of aluminium chloride

Dimerisation of AlCl3 (aluminium chloride)



Bond polarity

describes how electrons are shared between atoms in a covalent bond (shifting of the electron cloud)

non-polar bonds (X-X,C-H,P-H) : negligible difference in electronegativity, electron cloud shared equally

polar bond: atoms have relatively different electronegativities. The more electronegative atom will attract the shared paired electrons towards itself more than the less electronegative atom. electron cloud will shift towards the more electronegative atom

Bond polarity (cont)

polarisation: seperation of positive and negative charges (in a polar bond, the more electronegative atom will have a partially negative charge whereas the less electronegative atom will have a partially positive charge

compounds with this type of covalent bond are said to behave ionically

dipole moment (indicate difference between electronegativities of the atoms bonded together (arrow points from PP to PN)

partially negative charge is not the same as negative charge (each used for different types of bonding)

Strength of a covalent bond

the more the bond energy, the stronger the covalent bond

bond energy: the energy absorbed when a mole of a particular covalent bond between 2 atoms in the gaseous state is broken

factors affecting bond energy: bond order, bond length

bond order: number of covalent bonds between 2 atoms (as bond order increases, bond energy increases, the more stronger the bond)

bond length: distance between the nuclei of the bonded atoms (as the radius of the bonded atoms increases, bond length increases, bond energy decreases, the weaker the bond

Covalent Compounds

most covalent compounds have a simple molecular structure, whereas some covalent compounds (diamond, graphite, silicon, SiO_2) have a giant covalent structure

simple molecular structure: strong covalent bonds between atoms, weak intermolecular forces between molecules. covalent compounds with this type of structure exist as simple discrete molecules

giant covalent compounds: strong covalent bonds between atoms. These strong covalent bonds **exists extensively throughout** the structure

Diamond

C atoms are arranged tetrahedrally, where 1 C atom uses all its 4 valence electrons to form 4 single covalent bonds with 4 other C atoms

very hard due to C atoms being held in a fixed tetrahedral arramgement with strong covalent bonds between C atoms

poor electrical conductor as each C atom is fully bonded to 4 other C atoms covalently (localised in the covalent bonds), leaving behind no delocalised electrons to carry charge

insoluble as a lot of energy is required to overcome the strong covalent bonds between atoms

high mp/bp: a lot of energy required to overcome strong covalent bonds between atoms

Graphite

C atoms are hexagonally arranged in flat parallel layers. weak instantaneous dipole-induced dipole attraction between parallel hexagonal layers

Each C atom uses only 3 valence electrons to form 3 single covalent bonds with only 3 other C atoms. the fourth valence electron from each C atom is delocalised over all C atoms in the same layer

good electrical conductivity **in the direction parallel to the hexagonal layers of C atoms** -> delocalised electrons along the layer can carry charge

insoluble as a lot of energy is required to overcome the strong covalent bonds between atoms

high mp/bp: a lot of energy required to overcome strong covalent bonds between atoms

soft: hexagonal layers are held by weak instantaneous dipole-induced dipole attraction -> weak enough to allow the layers to slide over one another(graphite is used as a lubricant)

Silicon

each Si atom forms 4 single covalent bonds with 4 other Si atoms in a tetrahedral arrangement

silicon is a semiconductor : Electricity does not conduct in this pure monocrystalline silicon, when silicon is doped with impurities it becomes conductive. But silicon does not have conductivity comparable to conductors, it is very less but much more than that of insulators which is why it is called a semiconductor.

SiO_2 (Silicon Dioxide)

Each Si atom forms 4 single covalent bonds with 4 oxygen atoms in tetrahedral arrangement. Each O atom forms 2 single covalent bonds with 4 O atoms

Each O atom forms 2 single covalent bonds with 2 Si atoms

Hence the ratio of Si:O -> 1:2

poor conductor of electricity, high mp

crystallized: quartz/ impure : sand

Simple Molecular structure

most covalent compounds have a simple molecular structure

hence most covalent compounds exist as simple discrete molecules

strong covalent bonds between atoms, weak intermolecular force between molecules (when heat is supplied, imf is overcome before covalent bonds)

low mp/bp: little energy required to overcome weak intermolecular forces of attraction between molecules

poor electrical conductivity: there are no mobile charge carriers (delocalised electrons) present in simple covalent molecules in all states

exception: some polar molecules such as HCl may dissociate in water to form H^+ and Cl^- ions (polar molecules behave ionically)

solubility: polar molecules are soluble in polar solvents/ non polar molecules are soluble in non polar solvents