No Brain Too Small ● CHEMISTRY AS 91164 Demonstrate understanding of bonding, structure, properties and energy changes

Types of solids

Ionic – between metal & non-metal (exception $AlCl_3$ covalent molecular); particles = IONS, attraction = ionic / electrostatic bond

Covalent – between metal and non-metal.

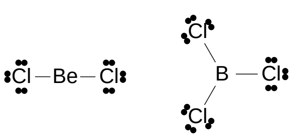
- COVALENT NETWORK; particles = atoms; attraction = covalent bond; E.g. diamond, graphite and silicon dioxide SiO_2.
- COVALENT MOLECULAR; particles = molecules; attraction = weak intermolecular forces; E.g. H_2O, I_2, CO_2.
- Metallic – bonding between metal atoms; particles involved = atoms; attraction = metallic bond; E.g. Ag

Lewis structures

Show only valence electrons. The number of valence electrons an atom has = its group # or group # – 10. E.g. Al – group 13. 13 – 10 = 3 valence electrons. (or work it out from Aluminium's atomic number of 13 which gives an electron arrangement of 2, 8, 3).

Pairs of electrons are drawn as ●● or x x

Simple molecules have no more than four electron pairs about any atom (including multiple-bonded species). $BeCl_2$ and BCl_3 are electron deficient (don't have octet around Be or B, the central atom).



Usually, the central atom is already known. Otherwise the atom with the lowest electronegativity is the central atom. NOTE: H can never be a central atom.

Defining bond types

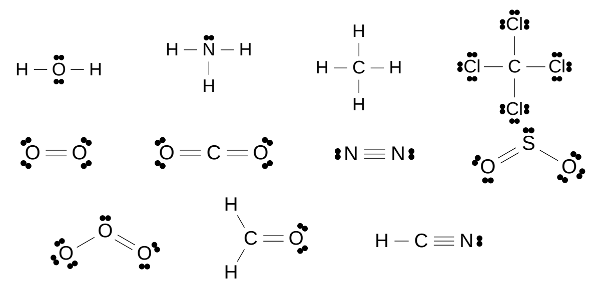
Metallic: attraction between loosely held valence electrons & positively charged nuclei of neighbouring atoms. (Or "metal cations in sea of delocalised electrons").

Ionic: electrostatic attraction between oppositely charged ions.

Covalent: bond in which one or more pairs of electrons are shared by two atoms. It's intramolecular (between atoms within the molecule).

Intermolecular: weak attraction between molecules (inter = between)

Other useful Lewis diagrams

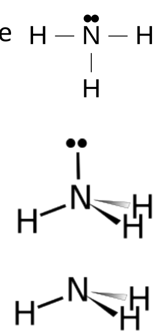


Bond angles and shapes of molecules

Based on repulsion of regions of negative charge. 2 regions – linear 180°, 3 regions – trigonal planar 120°, 4 regions tetrahedral – 109°.

Shapes of molecules are based around repulsion of regions of negative charge, boning and non-bonding BUT ultimately depend on the positions of the atoms.

E.g. NH_3



- 4 regions of negative charge around the central N atom which repel each other to get as far away from each other as possible, taking up the arrangement of a regular tetrahedron.
- 3 regions are bonding, one non-bonding – and so the shape of the molecule is trigonal pyramidal, with bond angle approximately 109°.

Explaining properties

Hardness – indicates strong metallic, covalent or ionic bond – much energy needed to overcome attraction.

High m.pt, b.pt – indicates strong attraction between atoms or ions (metallic, covalent network or ionic bond).

Brittle – indicates ionic bond (when like charged ions line up they repel)

Low m.pt, b.pt, soft - indicates weak attraction / weak intermolecular forces between molecules (molecular covalent)

Malleable, ductile – indicates the non-directional attraction due to metallic bond.

Conducts electricity – has "mobile charge carriers" – delocalised electrons in metals (and graphite) OR ions in molten or aqueous ionic substances. (NOTE: In solid ionic substances the ions are NOT free to move).

Solubility - non-polar substances e.g. I_2 dissolve in non-polar solvents e.g. hexane, because similar weak intermolecular forces exist between I_2 and hexane molecules as did between I_2 and I_2 molecules and between cyclohexane and cyclohexane molecules. Polar covalent molecules and many ionic solids dissolve in polar solvents (e.g. H_2O) due to attraction between charged particles. (DO NOT call ionic solids "polar" – they are not!)

Polar or non polar molecules

To predict if a bond is polar, consider electronegativity, the ability of atoms *in a bond* to attract electrons to themselves. Inc → periodic table, inc ↑ a group. Remember (most)…F O N/Cl S/C H (less). Show EN with δ+ and δ- above atoms.

Predicting if molecule is polar or not. *Polar molecules*: contain polar bonds AND their lack of molecule symmetry means dipoles do not cancel out, e.g. H_2O. *Non-polar molecules*: usually contain polar bonds BUT the molecule symmetry means dipoles do cancel out e.g. O=C=O ; OR do not contain polar bonds e.g. where atoms of same electronegativity are bonded, e.g. Cl-Cl.