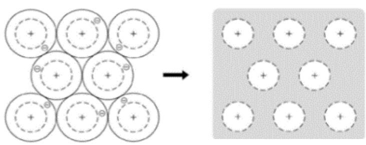
Exmouth Community College
Academy Trust

C3 Structure and Bonding

Year 11 – Chemistry / – HT2

Metallic Bonding

Metals LOSE ELECTRONS to form POSITIVE IONS



Delocalised electrons

GIANT structures of atoms in a REGULAR pattern

Delocalised electrons are free to move.

What is a metallic bond?

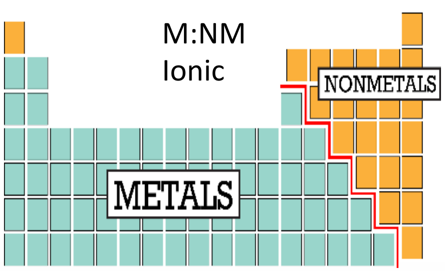
Sharing delocalised electrons – STRONG metallic bonds.

Which type of bonding is it?

M:M
Metallic

NM:NM
Covalent

M:NM
Ionic

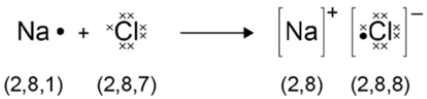


Ionic Bonding

Metals LOSE ELECTRONS to form POSITIVE IONS

Non-metals GAIN ELECTRONS to form NEGATIVE IONS

Electrons transferred from metal to non-metal



Ions have electronic structure of a noble gas

What is an ionic bond?
STRONG electrostatic force of attraction between **oppositely charged ions**

How do we quickly work out the charges on ions?

Group	Electrons in outer shell	Charge on ion
1	1	1+
2	2	2+
6	6	2-
7	7	1-

Covalent Bonding

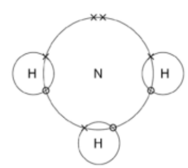
Two **non-metals** will **SHARE** pairs of electrons

STRONG bond formed

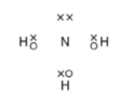
Small molecules

A small group of atoms sharing electrons

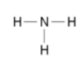
For ammonia (NH_3)



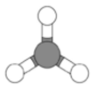
and/or



and/or

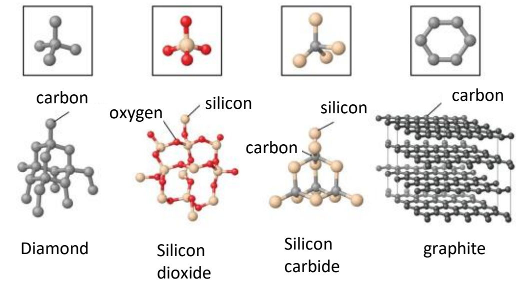


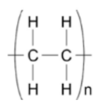
and/or



Giant structures

Many atoms sharing electrons

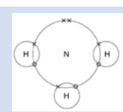
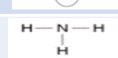
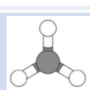




polymers

Poly(ethene)

Limitations of these models

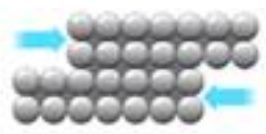
Model		Limitations
	Dot and Cross	Looks like electrons aren't identical Electrons look like that are in fixed positions
	Displayed Formula	Doesn't show true shape of the molecule
	Ball and Stick	Can attempt to show 3D shape but doesn't show electrons

Properties of Metallic Substances

Metals have high melting and boiling points **because . . .**

. . . they are **giant structures** of atoms with **strong metallic bonding**

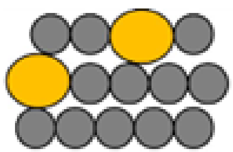
Can be bent or shaped **because. . .**

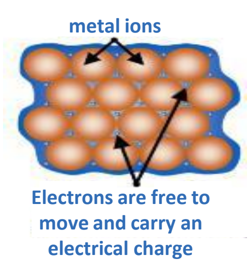


. . . atoms are arranged in LAYERS which can SLIDE over each other

Alloys are harder than pure metals **because . . .**

Alloys are a mixture of two or more elements, at least one of which is a metal





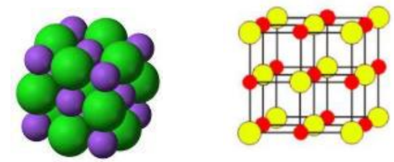
. . . the layers are DISTORTED so can't slide over each other

Metals are good conductors of electricity and thermal energy **because . . .**

. . . the **electrons are free** to move and carry thermal energy and charge

Properties of Iconic Substances

Ionic compounds have high melting and boiling points **because . . .**

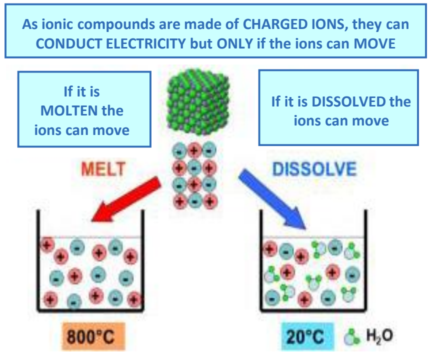


. . . they are giant structures of atoms (giant ionic lattice) with **strong electrostatic forces** of attraction in **ALL DIRECTIONS** between oppositely charged ions.

A large amount of **energy** is needed to break the many strong bonds.

Only conduct electricity when melted or dissolved in water **because . . .**

the **ions are free** to move and so charge can flow



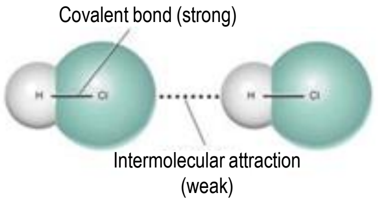
Exmouth Community College
Academy Trust

C3 Structure and Bonding

Properties of Covalent Substances

Small molecules

Small molecules have relatively low melting and boiling **points because . . .**



. . . **intermolecular forces** are over come on melting and boiling and these are weak forces

The bigger the size of the molecule the higher the melting and boiling point **because . . .**

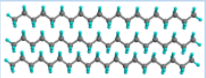
. . . intermolecular forces increase with the size of the molecules

Don't conduct electricity **because . . .**

. . . the molecules have **no overall electric charge**

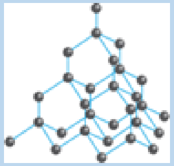
Giant Structures

Polymers are solids at room temperature **because . . .**



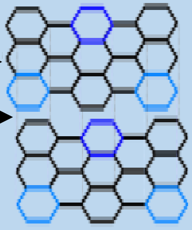
. . . intermolecular forces increase with the size of the molecules and polymer molecules are very large

Diamond is very hard, has a very high melting and boiling point and doesn't conduct electricity **because . . .**



. . . Each carbon is bonded to **4** other carbons by **strong covalent bonds**. There are **no free electrons**

Graphite is very hard, has a very high melting point and does conduct electricity **because . . .**

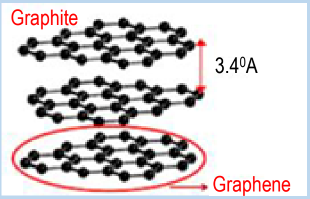


. . . Each carbon is bonded to **3** other carbons by **strong covalent bonds**. It forms **layers** of **hexagonal rings** with no covalent bonds between the layers. There are **free electrons**

Giant covalent compounds have high melting and boiling points **because . . .**

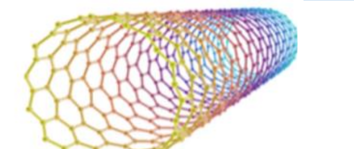
. . . All of the atoms linked by **strong covalent bonds**

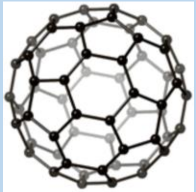
Graphene is strong, light and an excellent conductor of thermal energy and electricity **because . . .**



. . . It is a single layer of graphite so has **free electrons**

Fullerenes (e.g. carbon nanotubes) are extremely strong and are excellent conductors of thermal energy and electricity **because . . .**


Carbon nanotube


Fullerene

. . . They have **strong covalent bonds** and **free electrons**

QUANTITIVE CHEMISTRY : KNOWLEDGE ORGANISER

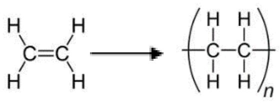
	Know The Facts		Key Words
1	The law of conservation of mass states that no atoms are lost or made during a chemical reaction so the mass of the products equals the mass of the reactants	1	**Avogadro constant** the number of atoms, molecules or ions in a mole of any substance (i.e. 6.02×10^{-23} per mol)
2	In a balanced chemical equation, the sum of the relative formula masses of the reactants in the quantities shown equals the sum of the relative formula masses of the products in the quantities shown	2	**mole** the amount of substance in the relative atomic or formula mass of a substance in grams. The symbol for the unit mole is mol
3	When a metal reacts with oxygen the mass of the oxide produced is greater than the mass of the metal	3	**concentration** the amount of a substance dissolved in a given volume of liquid
4	In thermal decompositions of metal carbonates carbon dioxide is produced and escapes into the atmosphere leaving the metal oxide as the only solid product	4	**limiting reactant** the reactant in a chemical reaction that when used up causes the reaction to stop
5	The masses of reactants and products can be calculated from balanced equations. Chemical equations can be interpreted in terms of moles $Mg + 2HCl2 \quad M_gCl_2 + H_2$ shows that one mole of magnesium reacts with two moles of hydrochloric acid to produce one mole of magnesium chloride and one mole of hydrogen gas	5	**percentage yield** the actual mass of product collected in a reaction divided by the maximum mass that could have been formed in theory, multiplied by 100 The amount of a product obtained is know as the yield $\% \text{ Yield} = \frac{\text{mass of product actually made}}{\text{Maximum theoretical mass of product}}$ x100
6	In a chemical reaction involving two reactants, it is common to use an excess of one of the reactants to ensure that all of the other reactant is used	6	**relative formula mass M_r** the total of the relative atomic masses, added up in the ratio shown in the chemical formula, of a substance
7	The percentage atom economy of a reaction is calculated using the balanced equation for the reaction as follows: $\frac{\textit{relative formula mass of desired product from equation}}{\textit{Sum of relative formula masses of all reactants from equation}} \times 100\%$	7	**relative atomic mass A_r** the average mass of the atoms of an element compared with carbon-12 (which is given a mass of exactly 12). The average mass must taken into account the proportions of the naturally occurring isotopes of the element

Year 11 – Chemistry / Bulk Properties – HT2

Exmouth Community College
Academy Trust

AQA BONDING, STRUCTURE AND THE PROPERTIES OF MATTER 2

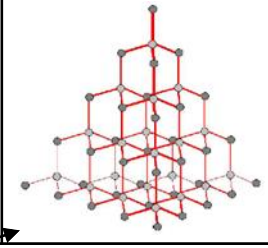
Polymers

Very large molecules	**Solids at room temp**	Atoms are linked by strong covalent bonds	

Properties of small molecules

Usually gases or liquids		
Covalent bonds in the molecule are strong but forces between molecules are weak (intermolecular)	Low melting and boiling points	Due to having weak intermolecular
	Do not conduct electricity	Due to them molecules not having an overall electrical charge
	Larger molecules have higher melting and boiling points	Intermolecular forces increase with the size of the molecules

Diamond

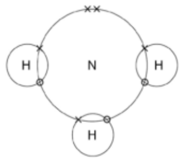
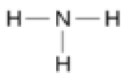
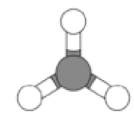
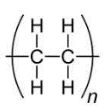
Each carbon atom is bonded to four others		Very hard	Rigid structure
		Very high melting point	Strong covalent bonds
		Does not conduct electricity	No delocalised electrons

Giant covalent structures

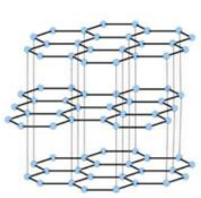
Diamond graphite, silicon dioxide	**Very high melting points**	Lots of energy needed to break strong, covalent bonds

Covalent bonding

Atoms share pairs of electrons

Can be small molecules e.g. ammonia		**Dot and Cross:** + Show which atom the electrons in the bonds come from - All electrons are identical
		**2D with bonds:** + Show which atoms are bonded together - It shows the H-C-H bond incorrectly at 90°
		**3D Ball and Stick model:** + Attempts to show the H-C-H bond angle is 109.5°
Can be giant covalent structures e.g. polymers		

Graphite

Each carbon atom is bonded to three others forming layers of hexagonal rings with no covalent bonds between the layers		Slippery	Layers can slide over each other
		Very high melting point	Strong covalent bonds
		Does conduct electricity	Delocalised electrons between layers

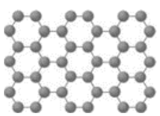
Size of particles and their properties (Chemistry only)

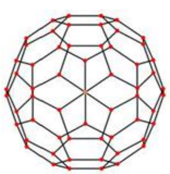
Nanoparticles	**Between 10 and 100 nanometres (nm) in size**	1 nanometre (1nm) = 1×10^{-9} metres (0.000 000 001nm or a billionth of a metre)

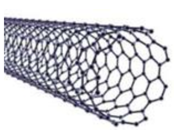
Use of nanoparticles

Healthcare cosmetics, sun cream, catalysts, deodorant, electronics	Nanoparticles may be toxic to people. The may be able to enter the brain from the bloodstream and cause harm

Graphene and fullerenes

Graphene	 **Single layer of graphite one atom thick**	Excellent conductor	Contains delocalised electrons
		Very strong	Contains strong covalent bonds

Fullerenes		Buckminsterfullerene, C_{60} First fullerene to be discovered	Hexagonal rings of carbon atoms with hollow shapes. Can also have rings of five (pentagonal) or seven (heptagonal carbon atoms)

Carbon nanotubes	 **Very thin and long cylindrical fullerenes**	Very conductive	Used in electronics
		High tensile strength	Reinforcing composite materials
		Large surface area to volume ratio	Catalysts and lubricants