Chemistry 2: Bonding, structure and properties of matter

Section 1: Types of bond

Type	Between	What happens
Ionic	Metals and non metals	Electrons are transferred – electrostatic attraction between oppositely charged ions
Covalent	Non metal and non metal	Electrons are shared
Metallic	Metal and metal	Attraction between positive ion and delocalised electrons

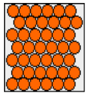
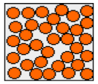
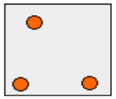
Section 2: Ionic formula

Ionic compound	Ratio	Formula of the compound
Sodium chloride	$Na^+ : Cl^-$ 1 : 1	$NaCl$
Calcium chloride	$Ca^{2+} : Cl^-$ 1 : 2	$CaCl_2$

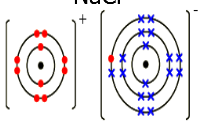
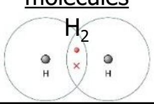
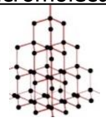
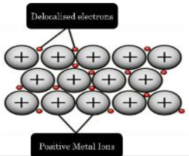
Section 2a: Common ions

Name	Ion
Hydroxide	OH^-
Sulfate	SO_4^{2-}
Carbonate	CO_3^{2-}
Nitrate	NO_3^-

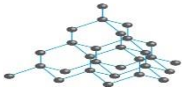
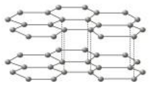
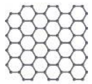
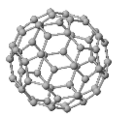
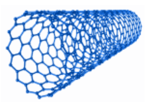
Section 3: States of matter

State	Diagram	Properties
Solid		Strong forces of attraction between particles. Particles are close together in lattice arrangement. The particles don't move from their positions so solids keep a definite shape. The particles vibrate in their positions – the hotter the solid, the more they vibrate (solids expand when hot).
Liquid		Weak force of attraction between particles. They are randomly arranged and free to move past each other (but they stick closely together). Liquids have a definite volume but not a definite shape – they can flow. The particles are constantly moving with random motion. The hotter the liquid gets, the faster they move (liquids expand when hot).
Gas		Very weak force of attraction between particles. They are free to move and are far apart. The particles in gases travel in straight lines. Gases don't keep a definite shape or volume. The particles move constantly with random motion. The hotter the gas gets, the faster they move. Gases either expand when heated, or their pressure increases.

Section 4: Bonding and properties

chemical bond	Exists between	Example	Properties
Ionic bonding	Metal and non-metal	NaCl 	Ionic compounds Giant lattice structure. Strong electrostatic forces of attraction between oppositely charged ions. High melting and boiling points. Do not conduct as a solid – ions cannot move Do conduct when melted/dissolved – ions can move.
Covalent bonding	Non-metals	Simple covalent molecules H_2 	Simple covalent molecules Do not conduct electricity. Strong covalent bonds between atoms but weak intermolecular forces between molecules – low melting and boiling points.
		Giant covalent molecules (macromolecules) 	Giant covalent molecules (macromolecules) Do not conduct electricity – no ions or delocalised electrons (exceptions include graphite). Strong covalent bonds and all atoms bonded to each other – high melting and boiling points.
Metallic bonding	Metals	Sodium 	Delocalised electrons carry current and thermal energy well - conduct electricity and heat. Strong electrostatic forces of attraction between positive ions and electrons - high melting/boiling points. Layers can move around so metal is malleable/ductile. Each metal puts in electrons, the more electrons in the cloud = stronger bonding. Alloys (a metal mixed with another element) – stronger as the different sized atoms distort the layers so they cannot slide over each other.

Section 5: Structure and bonding of carbon

Allotrope of carbon	Structure	Properties	Use
Diamond		Each carbon atom has 4 covalent bonds – diamond is very hard These strong bonds take a lot of energy to break – diamond has a very high melting point. It doesn't conduct electricity as there are no free electrons or ions.	In drill bits.
Graphite		Each carbon atom has 3 covalent bonds (each atom has 1 delocalised electron) – the delocalised electron allows graphite to conduct electricity and thermal energy. The covalent bonds take a lot of energy to break – graphite has a high melting point. There aren't any bonds between layers – this makes graphite soft and slippery.	As lubricants.
Graphene		Graphene is on one atom think – it is a 2D compound. The network of covalent bonds makes it very strong and very light – it can be added to materials to improve their strength without adding much weight. It contains delocalised electrons so can conduct electricity through the whole structure.	In electronics.
Fullerenes		Fullerenes are molecules of carbon, shaped like closed tubes or hollow balls. They are arranged in hexagons (or pentagons or heptagons). They can trap molecules inside them. They have a huge surface area. The first fullerene to be discovered was the Buckminsterfullerene (C_{60}).	For drug delivery. To make carbon nanotubes. Lubricants (they roll)
Fullerenes as nanotubes		Nanotubes are tiny carbon cylinders. The ratio between the length and the diameter of nanotubes is very high. They can conduct both electricity and thermal energy. They have high tensile strength.	In electronics. For tennis rackets.

Section 6: Bulk and surface properties of matter

Type of particles	Size in nm	Size in m
Nanoparticles	1-100	1×10^{-9} to 1×10^{-7}
Fine particles ($PM_{2.5}$)	100-2500	1×10^{-7} to 2.5×10^{-6}
Coarse particles (PM_{10})	2500-10000	1×10^{-5} to 2.5×10^{-6}

Section 6a:nUses of nanoparticles

Use	Why? (property)
Catalysts	Due to their huge surface area to volume ratio.
Medicine (to deliver drugs)	They are small and more easily absorbed into the body.
Computer chips	Some nanoparticles conduct electricity.
Surgical masks and wound dressings	Silver nanoparticles have antibacterial properties.
Cosmetics	To improve moisturisers without making them oily.

Section 7: Surface area to volume ratio

As the side of cube decreases by a factor of 10 the surface area to volume ratio increases by a factor of 10.

How to calculate	Surface area to volume ration = surface area ÷ volume

Section 6b: Disadvantages of nanoparticles

Effects on the body are unknown so there may be some risks. All products containing them should be labelled.