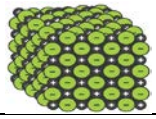
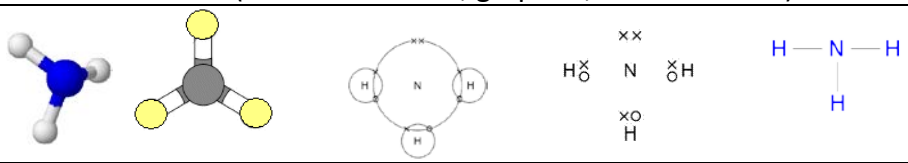
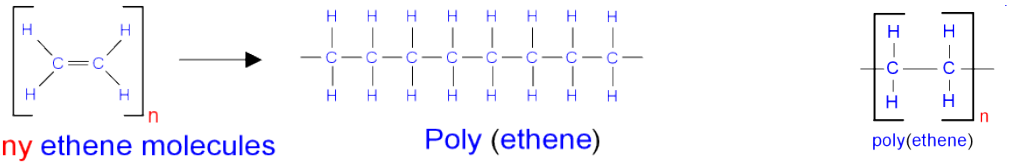
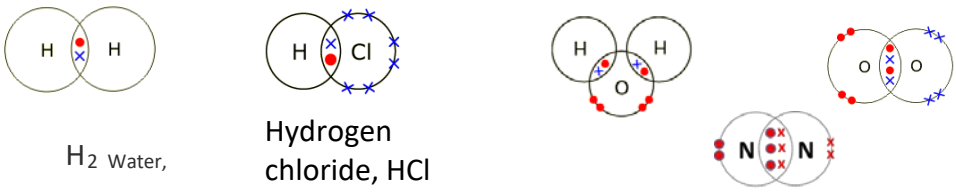
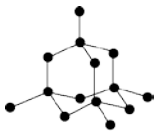
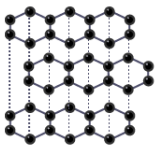
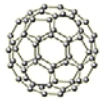
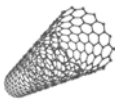
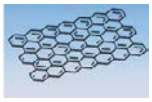
C4.2 Bonding, structure & the properties of matter – Knowledge organiser

Topic 1 – Ionic bonding

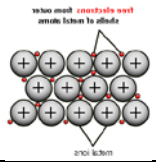
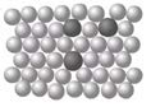
1	**Ionic bonding**	When a **metal atom** reacts with a **non-metal atom**. They lose or gain electrons to have a **FULL OUTER SHELL**. Metal atoms **LOSE electrons** to become **positively charged ions**. Non-metal atoms **GAIN electrons** to become **negatively charged ions**. The ions produced by Groups 1 & 2 and by Groups 6 & 7 have the electronic structure of a noble gas (Group 0) The charge on the ions produced by Groups 1 & 2 and Groups 6 & 7 relates to the group number of the element in the Periodic Table.
2	**Ionic compounds** 	An ionic compound is a giant structure of atoms (**GIANT IONIC LATTICE**) They are held together by **STRONG ELECTROSTATIC ATTRACTIONS** between **OPPOSITELY CHARGED IONS**. These forces act in **all** directions.
3	**Properties of ionic compounds**	**High melting points** and **high boiling points** – large amounts of energy is required to **break** the **strong electrostatic attractions**. **Solids** Do not conduct electricity as the strong electrostatic attractions do not allow the ions to move – ONLY conducts when **melted** or **dissolved**. This is because the **ions** are now **free to move**.

Topic 3 – Covalent bonding

1	**Covalent bonding**	This occurs when atoms **share pairs of electrons**. These bonds between atoms are strong. Covalently bonded substances may consist of small **molecules**, very large molecule (such as polymers) or giant covalent structures (such as diamond, graphite, silicon dioxide).
2	**Representing covalent bonds**	Ammonia, NH_3 
3	**Representing polymers**	 Many ethene molecules Poly (ethene) poly(ethene) Polymers are **very large molecules**. Atoms are linked by **strong covalent bonds**. The **INTERMOLECULAR FORCES** between molecules are relatively so strong, so they are usually solid at room temperature.
4	**Small covalent molecules**	Hydrogen,  H_2 Water, Hydrogen chloride, HCl
5	**Properties of small**	Usually gases or liquids (some can be solids). Have a relatively **low melting point** and **boiling points. WEAK INTERMOLECULAR FORCES** between molecules. It is these that are easily broken when they melt or boil, **NOT** the covalent bond.

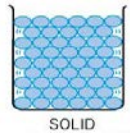
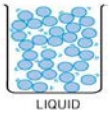
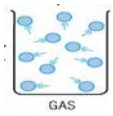
	covalent molecules	Intermolecular forces increase with molecule size. So, the **larger the molecule**, the **higher the melting and boiling point**. They **do not** conduct electricity as they have **no overall electric charge**.
6	**Giant covalent structures**	All atoms in a structure are linked together by very strong covalent bonds.
7	**Diamond** 	Each **carbon** atom forms **4 covalent bonds** with other carbons. Does **not conduct** electricity as there are **NO delocalised electrons**. **Very hard**. **Very high melting point** due to the **strong covalent bonds** requiring lots of energy to break.
8	**Graphite** 	Each **carbon** atom forms **3 covalent bonds** with 3 other carbons. One **electron** is **delocalised** meaning it will **conduct electricity**. Forms layers of **hexagonal rings** which have **weak intermolecular forces between** the **layers** – this makes it a good **lubricant** as the layers slide over each other. **Very high melting point** due to the strong covalent bonds requiring lots of energy to break.
9	**Graphene & fullerenes**  	 **Graphene:** single layer of graphite, used in electronics and composites **Fullerenes** - molecules of carbon atoms with hollow shapes - structure based on hexagonal rings of carbon atoms or rings of 5 or 7 atoms - Buckminsterfullerene, C_{60} (left) was the first to be discovered **Carbon nanotubes** - cylindrical fullerenes, very high length to diameter ratios - useful for nanotechnology, electronics and materials

Topic 4 – Metallic bonding

1	**Metallic bonding** 	Giant structures of atoms arranged in a regular pattern. Electrons in the outer shell are **delocalised** and so are **free to move** through the whole structure. The sharing of delocalised electrons form metallic bonds.
2	**Properties of metals and alloys**	Giant structures with **strong metallic bonds** so most metals have **high melting** and high boiling points. **Good conductors** of heat and electricity – they are transferred by the delocalised electrons. **Pure metals** – atoms are arranged in **layers**, which allow metals to be **bent** and **shaped** as they can **slide over each other**. They are too soft for many uses and so are mixed with other elements to make an alloy.
3	**Alloys** 	**Mixture** of **2 or more elements**, **one** of which must be a **metal**. Alloys are harder as the **layers** get **distorted** and **can't slide** over each other.

Topic 5 – The three states of matter

1	**Melting point**	Point at which a solid turns to a liquid (melting) and liquid turns to a solid (freezing).
2	**Boiling point**	Point at which a liquid turns to a gas (boiling) and a gas turns to a liquid (condensation).

3	The 3 states of matter can be represented by a simple model.		
			
4	The amount of energy needed to change state from a solid to a liquid and from a liquid to a gas depends on the strength of the forces between particles. The **stronger the forces,** the **higher the melting** and boiling point.		
5	***<u>Limitations (HT only):</u> The models above show no forces, All particles are represented in spheres, All spheres are solid***		
6	(S) = Solid, (l) = liquid, (g) = gas, (aq) = aqueous solutions		

Topic 6 – Nanoparticles *<u>(chemistry only)</u>*		
1	**Size of particles**	**1 – 100nm** in size Smaller than fine particles ($PM_{2.5}$), which have diameters between 100 and 2500 nm (1×10^{-7} m and 2.5×10^{-6} m) Coarse particles (PM_{10}) have diameters between 1×10^{-5} m and 2.5×10^{-6} m (referred to as dust).
2	**Properties of nanoparticles**	As the side of a cube decreases by a factor of 10 the **surface area to volume ratio increases by a factor of 10**. (1 order of magnitude)The properties are different from the same material in bulk because of their high surface area to volume ratio. Smaller quantities are needed to be effective compared to normal particle sizes.
3	**Uses of nanoparticles**	- Medicine, Electronics, Cosmetics & sun creams, Deodorants, Catalysts