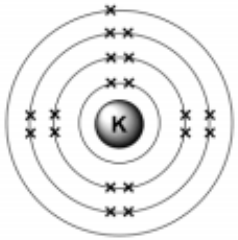
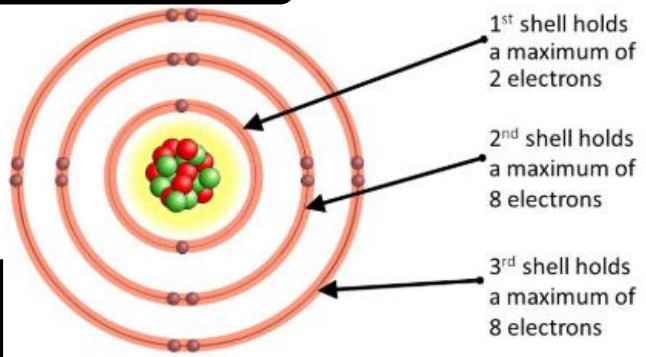
C2 Bonding structure and the properties of matter

11. Electron configuration

The electrons of an atom occupy the lowest possible energy level. The number of electrons in an uncharged atom are equal to the atomic number. They can be represented in their energy levels as numbers or diagrams: Potassium can be represented as 2.8.8.1 or…

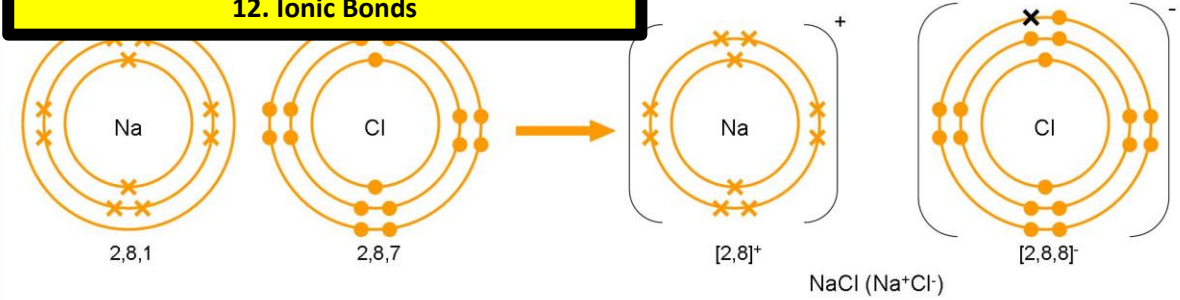


Atoms want to have a full outer shell as this makes them stable. To do this they form bonds with other atoms.



This electron arrangement is written as 2,8,8.

12. Ionic Bonds



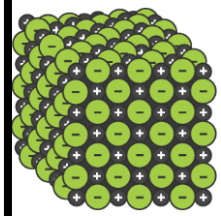
Metals and non-metals will form ionic bonds. The **metal** atom **loses electrons** to become a **positive** ion(cation) and the **non-metal** atom **gains electrons** to become a **negative** ion (anion).

The electrons from the metal transfer to the non-metal so that both ions have a full outer shell.

The ions formed are attracted by an electrostatic force.

13. Ionic compounds

Ionic compounds forma giant structure called a lattice.

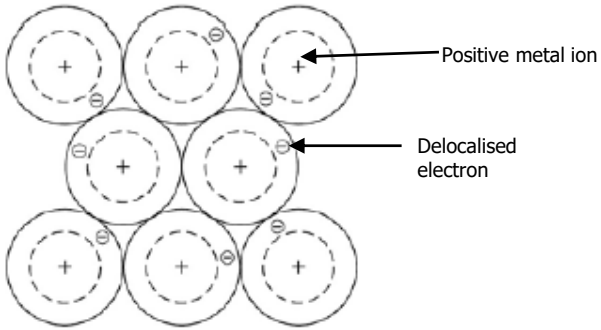


The electrostatic attraction is strong meaning ionic compounds have a high melting point as a lot of energy is needed to overcome the attraction.

Ionic compounds don't conduct when solid because the ions are locked in position. When molten the ions are free to move and can conduct.

14. Metallic Bonds

Metallic bonds are metal ions surrounded by delocalised electrons.

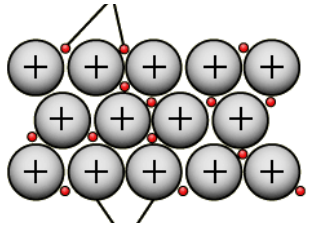


The metallic bonds are strong and so they have a high melting point. **There are strong electrostatic forces** between the **positive ions** and **delocalised electrons**. Requires a **large amount of energy** to overcome.

Metals are malleable (can be bent and shaped) and are ductile (can be pulled into wires) because the layers of ions are able to slide over each other.

Metals con duct electricity because the electrons are free to move.

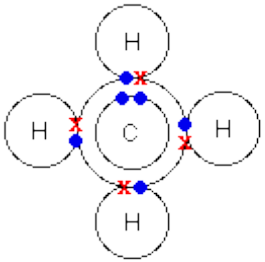
Free 'delocalised' electrons can flow between the metal ions.



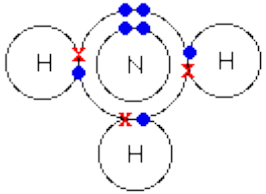
Metal ions

15. Covalent Bonds

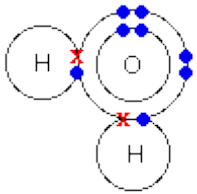
Non-metal atoms will form covalent bonds. The atoms **share electrons** to make themselves stable.



methane



ammonia



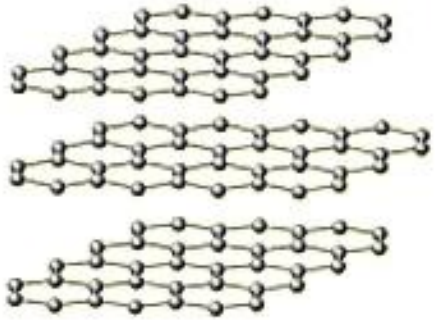
water

Although the covalent bond is strong the simple molecules are held together by weak intermolecular forces. This means they have low boiling points.

The covalent molecules don't conduct electricity because there are no free electrons.

16. Giant covalent structures

Giant covalent structures contain a lot of non-metal atoms, each joined to adjacent atoms by *covalent bonds*. The atoms are usually arranged into giant regular *lattices* - extremely strong structures because of the many bonds involved. Substances with giant covalent structures have very high melting points, because a lot of strong covalent bonds must be broken.



Graphite

Graphite is a form of carbon in which the carbon atoms form layers. These layers can slide over each other, so graphite is much softer than diamond. It is used in pencils, and as a *lubricant*. Each carbon atom in a layer is joined to only three other carbon atoms. Graphite conducts electricity because it has free electrons that can flow through the structure.

Diamond

Diamond is a form of carbon in which each carbon atom is joined to four other carbon atoms, forming a giant covalent structure. As a result, diamond is very hard and has a high melting point. It does not conduct electricity.

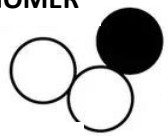
Silica

Silica, which is found in sand, has a similar structure to diamond. It is also hard and has a high melting point, but contains silicon and oxygen atoms, instead of carbon atoms. The fact that it is a semi-conductor makes it immensely useful in the electronics industry: most transistors are made of silica.

17. Polymers

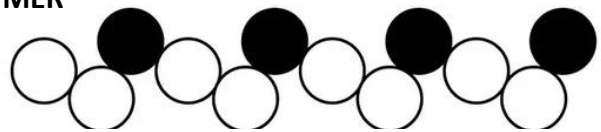
Structure of Monomers and Polymers

MONOMER



A monomer is a small molecule.

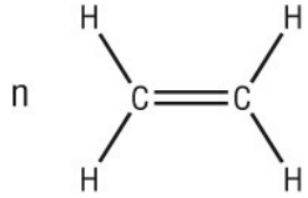
POLYMER



A polymer is a long-chain molecule made up of a repeated pattern of monomers.

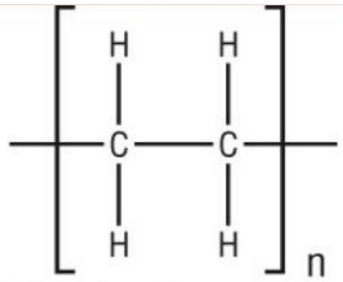
Longer chained polymers have a higher boiling point as the intermolecular forces increases as the polymer length increases.

MONOMER



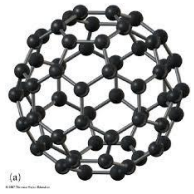
Ethene

POLYMER

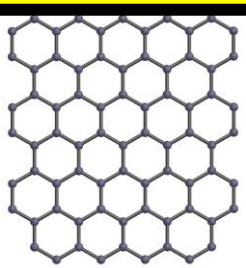


Poly(ethene) – *polythene*

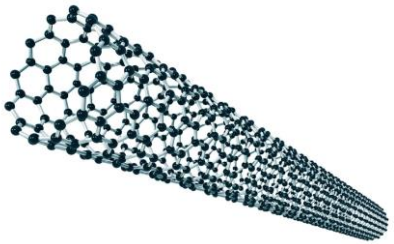
18. Small carbon based covalent structures



26 Fullerene



27 Graphene

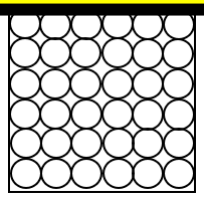


28 Carbon nanotube

19. Properties of small carbon based covalent structures

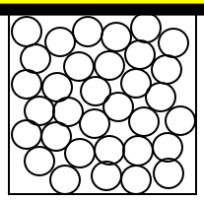
	Structure	Properties	Uses
Fullerene	**Hollow-shaped**. Usually **hexagonal rings of carbon** atoms. E.g. Buckminsterfullerene (C_{60})	Very **strong**. Hollow so can contain other chemicals within it.	**Drug delivery, lubricants**.
Graphene	A **single layer of graphite**.	Very **strong**. **Has delocalised electrons** so it is able to **conduct electricity**.	**Electronics, composites.**
Carbon nanotube	**Cylindrical tubes** of carbon atoms that are **very long** compared to their diameter.	Very **strong, light** and **flexible**. Has **delocalised electrons** so it is able to **conduct electricity**.	**Nanotechnology, electronics, reinforcing (e.g. tennis rackets).**

20. States of matter



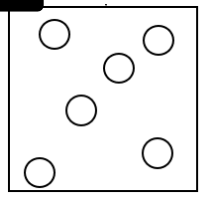
42 Solid

State symbol – (s)



43 Liquid

State symbol – (l)

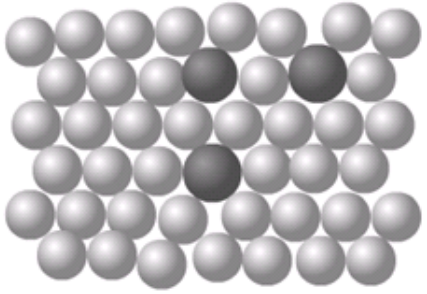


44 Gas

State symbol – (g)

21. Metal alloys

Alloys are usually a **mixture** of metals but can contain **non-metal atoms** too. Alloys have a m**ixture of different size atoms**.

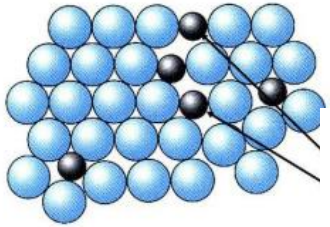


The different sized atoms **distort the layers**, making it **more difficult** for them to **slide** over one another. This usually makes the alloy **less malleable, ductile and harder than the pure metal that it is predominantly made of!**

Common alloys include amalgam, brass, solder and steel.

For example different amounts of carbon atoms can be added to iron to make steel. This makes the layers slide less easily.

High carbon steel is stronger than low carbon steel because it contains more carbon atoms spread through the layers of iron atoms. This means that the layers of iron atoms in high carbon steel are more distorted and irregularly arranged compared to the layers of iron atoms in low carbon steel.



The different sized carbon atoms in the layers stop the iron atoms sliding as easily over one another when a force is applied

The consequence of this is that the layers are less able to slide as easily over one another, making the metal less malleable and less ductile. High carbon steel has a higher tensile strength than low carbon steel.

Keyword	Definition	Keyword	Definition
1. Atoms	The smallest part of an element that can still be recognised as that element.	13. Reactant	The substances you start a reaction with
2. Element	A substance made up from only one type of atom. An element cannot be broken down chemically into any simpler substance.	14. Product	The substances made from the reaction
3. Compound	A substance made when two or more elements are chemically bonded together.	15. Symbol Equation	An equation that uses the symbols for elements found in the periodic table.
4. Mixture	When some elements or compounds are mixed together and intermingle but do not react together (i.e. no new substance is made)	16. Word Equation	An equation that uses words to name the substances found in the reaction.
5. Periodic Table	An arrangement of elements in the order of their atomic numbers, forming groups and periods.	17. Law of the conversation of mass	The total mass of the products formed in the reaction is equal to the total mass of the reactants.
6. Group	A column of the periodic table.	18. State symbol	Added to a reactant or product to tell you whether or not a substance is solid (s), liquid, (l), gas, (g) or aqueous (aq)
7. Period	A row of the periodic table.	19. Atomic Number	The amount of protons found in the nucleus for that particular element.
8. Nucleus	The very small and dense central part of an atom that contains protons and neutrons.	20. Ion	When an electron is either gained or lost from an atom
9. Electron	A tiny particle with a negative charge. Electrons orbit the nucleus of atoms or ions in shells. It has a negligible mass.	21. Isotope	When the number of electrons and protons for an element is the same but the neutrons have changed
10. Proton	A tiny positive particle found inside the nucleus. It has a mass of one.	22. Shell	Electrons are arranged around the nucleus, going up in energy per shell.
11. Neutron	A dense particle found in the nucleus of an atom. It is electrically neutral, carrying no charge.	23. Electronic Structure	The arrangement of electrons around the nucleus. There are 2 electrons in the first shell, and 8 in every shell after that.
12.	A grouping of two or more atoms	24. Noble	Gases that always have a full outer

25. Anion	A negatively charged ion
26. Boiling point	Temperature at which substance changes from a liquid to a gas
27. Cation	A positively charged ion
28. Covalent bond	A shared pair of electrons between atoms
29. Delocalised electrons	Free moving electrons from the outer shell of metal atoms. Form a strong attraction with metal ions
30. Dot and cross diagram	Diagram showing how electrons are arranged in a molecule or ion (dots for one atom, crosses for another atom)
31. Electrical conductivity	Measure of how well a substance conducts electricity
32. Electron	Negatively charged sub atomic particle
33. Electron transfer	Movement of electrons from one atom to another
34. Electrostatic attraction	Force of attraction between oppositely charged ions
35. Intermolecular force	Relatively weak force of attraction between molecules that keeps them together
36. Ion	Particle with a charge, positive or negative
37. Ionic bond	Forms between metals and non-metals. Oppositely charged ions attract to form an ionic bond.
38. Ionic formula	How ionic compounds are represented
39. Ionic lattice	Regular arrangement of positive ions surrounded by negative ions
40. Melting point	Temperature at which substance changes from a solid to a liquid
41. Metal ions	Positively charged atom in a metal
42. Metallic bond	Forces that keep atoms together in a metal
43. Molecule	Two or more atoms chemically joined
44. Covalent bond	Two shared electrons joining atoms together
45. Simple covalent molecule	Substance that contains only a few non-metal atoms held together by covalent bonds
46. Stable	An atom is stable when it has a full outer shell
47. Polymer	Long chain molecule made from joining lots of small molecules together by covalent bonds
48. Monomer	The building block (molecule) of a polymer
49. Delocalised	Free to move around