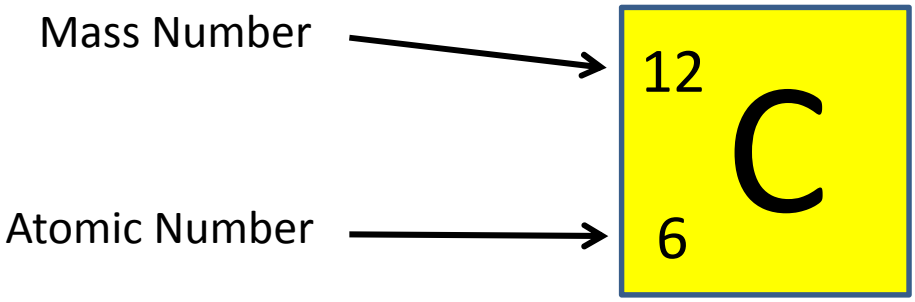
Atomic Structure

- An atoms nucleus contains **protons** and **neutrons**.
- **Electrons** orbit the nucleus in **shells**
- **Same number** of electrons and protons.

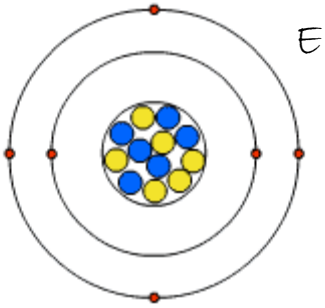
Sub-atomic Particle	Mass	Charge
Proton	1	+
Electron	Almost 0	-
Neutron	1	0



Electron Arrangement

Maximum of 2 in the first shell, 8 in subsequent shell

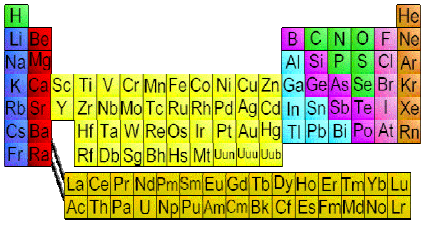
Electron arrangement in carbon:



Electron configuration = [2, 4]

Elements with a **full** outer shell are **unreactive**

Horizontal rows – **periods**: as we move one across the electron number increases by one.
Vertical rows – **groups**: elements in a vertical row have similar chemical properties.



Ionic Bonds

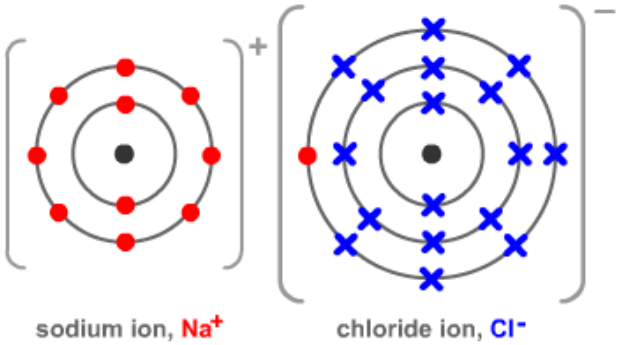
Ionic

- Bonding between **metals** and **non-metals**
- Involves giving and receiving of electrons in order to fill up outer shells like noble gases
- example: Sodium 2,8,1 – looses one electron (easier to lose one electron than to gain seven)
- When an atom looses an electron they are left with one more proton in the nucleus than electrons orbiting the nucleus. This makes sodium have a plus charge **(Na+)**.
- During chemical bonding **ions** are formed.

<u>There is a quick way to work out what the charge on an ion should be:</u>

- the number of charges on an ion formed by a **metal** is **equal to the group number** of the metal
- the number of charges on an ion formed by a **non-metal** is **equal to the group number minus eight**
- E.g. hydrogen forms H^+ ions, magnesium forms Mg^{2+} ions

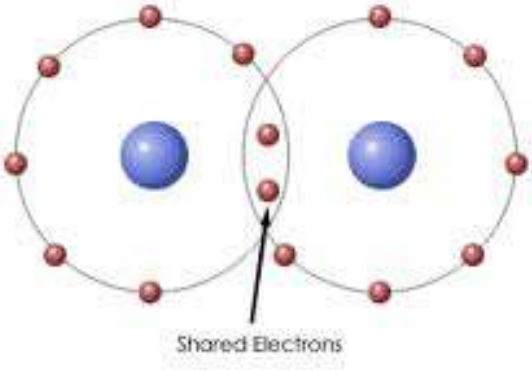
- Ionic bonding can be represented by dot and cross diagrams



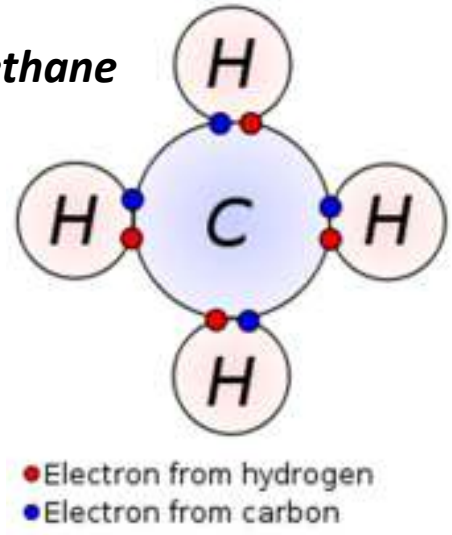
Covalent Bonds

Covalent

- Bonding between **non-metals** and **non-metals**
- The atoms **share electrons** in order to complete their outer shells.
- The atoms all attain noble gas structure (complete outer shells).
- The new particles formed are neutral molecules.



Methane



Ionic Compound	Covalent Compound
Non-metal + Metal	Non-metal + Non-metal
Transfer electrons (metal to non-metal)	Sharing electrons
Positive and negative charges	No charges
Naming with Greek Prefixes	Naming with Roman Numerals
Solid at room temperature (25℃)	Solid, liquid or gas at room temperature
High melting and boiling points	Low melting and boiling points
High attraction between particles	Weak attraction between molecules

Structures of Substances

There are four main structures of substances:

- Simple Molecular
- Giant Ionic
- Giant Covalent
- Giant Metallic

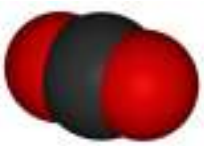
Simple Molecular Structures

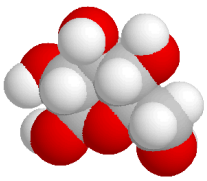
Small molecules containing few atoms (e.g. H_2O, CO_2)

Contain strong covalent bonds

Forces between atoms are super-strong

Forces between molecules are fairly weak



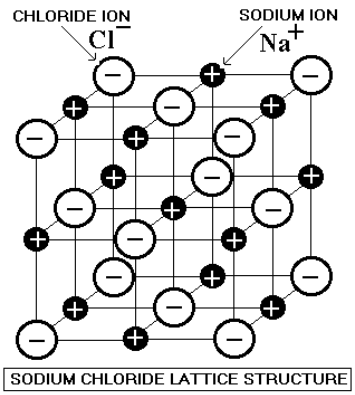


Typical Properties:

- Low melting point and boiling point
- Do not conduct electricity
- Tend to have little strength (soft)

Giant Ionic Structures

- Ions held together by strong attraction
- Forces **equal** in all directions in **lattice**
- Tightly packed ions
- Strong forces between ions



SODIUM CHLORIDE LATTICE STRUCTURE

Structures of Substances

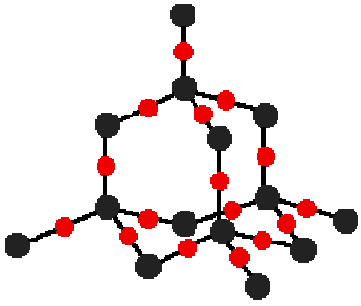
Ionic substances conduct electricity when they are molten because the ions are free to move around

Many can also be dissolved in water, where they will also conduct electricity (e.g. NaCl)

Giant Covalent Structures

- Large network of bonds – **giant covalent**
- Substances such as: **diamond, graphite and silicon dioxide**
- Held together in many strong covalent bonds
- They are **hard**
- **High melting and boiling points**
- **Unreactive** chemically
- Graphite has free electrons *delocalised electrons* **conduct electricity.**
- **Fullerenes:** carbon's ability to make large cage like structures. Important in nanoscience and industry

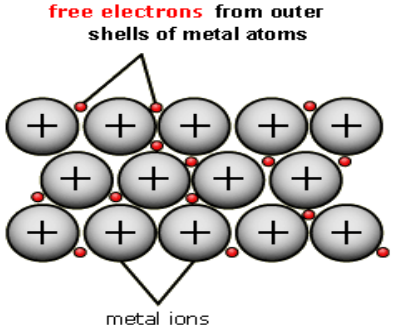
Diamond	Graphite	Sand
Carbon based	Carbon based	Carbon based
Each C joins to **4** others	Each C joins to **3** others	Each **silicon** joins to **4** oxygens
VERY hard	1 free electron per carbon	Each **oxygen** joined to **2** silicon
No electrical conductivity	Thus, conducts electricity	



Structures of Substances

Giant Metallic Structures

- The atoms in metals are in **layers** which can slide over each other, this makes it possible to bend them or beat them into shape.
- The atoms in metals share their outer electrons with all the other metal atoms, so that a metal consists of **positive ions** held together by **free electrons** which can move throughout the structure. Like other giant structures, the forces (called metallic bonds) holding the atoms together are very strong.



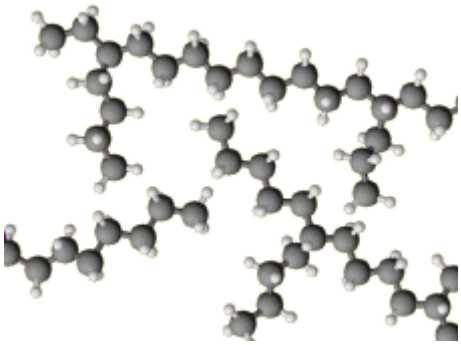
The main properties of metals are:

1) Metals are strong.
2) Most metals have high melting points.
3) Metals are malleable (they can be bent of beaten into different shapes)
4) Metals are good conductors of electricity & heat
5) Metals are lustrous (shiny)

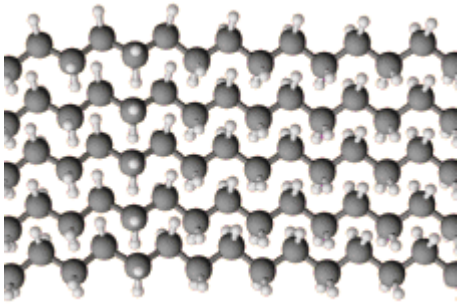
Polymers

The properties of polymers depend on what they are made of and by which method they are made.

High and low densities of polymer are made using different reactions and catalysts.



Low Density

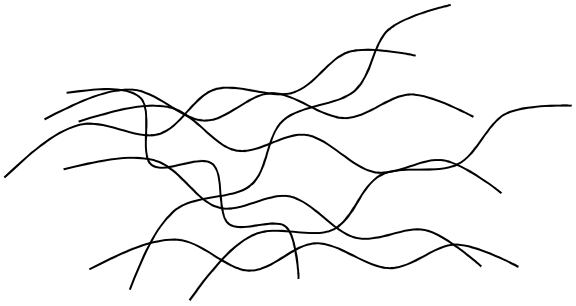


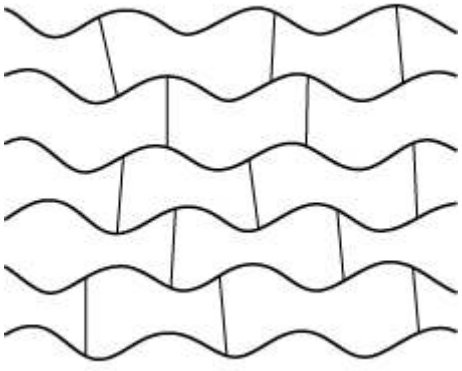
High Density

There are two types of plastic:

<u>Thermosoftening</u>

Individual tangled polymer strands. Melt when heated.



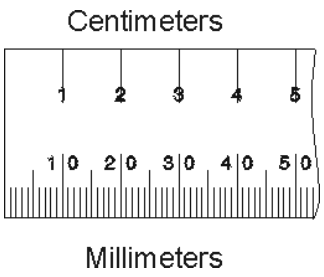


<u>Thermosetting</u>

Polymer chains with cross links between them. <u>Do not</u> melt when heated.

Nano Science

A nanometre (nm), is one billionth of a metre (or a millionth of a millimetre).



Nanoparticles range in size from about 100nm down to about 1nm.

Nanoparticles have a **very large surface area** compared with their volume, so they are often able to react very quickly.

They can, for example, be used in self-cleaning ovens and windows.

Nanoparticles also have different properties to the same substance in normal-sized pieces. For example, titanium dioxide is a white solid used in house paint and certain sweet-coated chocolates.

BUT, titanium dioxide nanoparticles cannot be seen as they are too small to reflect visible light. They are used in sun screens to block harmful ultraviolet light without appearing white on the skin.

Future developments in nanoscience might include:

- ❑ New catalysts
- ❑ New coatings
- ❑ New computers
- ❑ Stronger and lighter building materials
- ❑ Sensors that detect individual substances in tiny amounts