OCR A GCSE Chemistry

Topic 2: Elements, compounds and mixtures

Bonding

Notes

C2.2a describe metals and nonmetals and explain the differences between them on the basis of their characteristic physical and chemical properties

- Metals = elements that react to form positive ions.
  - Majority of elements are metals.
  - Found to the left and towards the bottom of the periodic table
  - they lose electron(s) in order to form positive ions
  - metals are typically shiny, good electrical conductors, are dense and have high melting points

- Non-metals = elements that react to form negative ions.
  - Found towards the right and top of the periodic table
  - they gain electron(s) in order to form these negative ions
  - nonmetals are typically dull in appearance, poor electrical conductors, aren't dense and have low melting points

C2.2b explain how the atomic structure of metals and nonmetals relates to their position in the periodic table

- see C2.2a

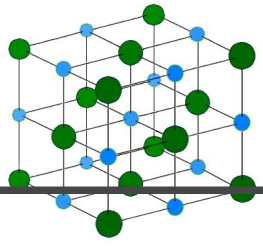
C2.2c explain how the position of an element in the periodic table is related to the arrangement of electrons in its atoms and hence to its atomic number

- Elements are arranged in order of atomic (proton) number and so that elements with similar properties are in columns, known as groups.
- Elements in the same periodic group have the same amount of electrons in their outer shell, which gives them similar chemical properties.
  - Group number refers to the number of outer shell electrons
  - Period number refers to the number of shells of electrons

C2.2d describe and compare the nature and arrangement of chemical bonds in:

- Ionic compounds:
  - ionic bonding
  - formed between a metal + non-metal: electrons in the outer shell of the metal atom are transferred to the nonmetal
  - Held together by strong electrostatic forces of attraction between oppositely charged ions

An example is sodium chloride (salt):
Na+ (small blue particles) and Cl- (larger green ones)



- Ionic compounds have regular structures (giant ionic lattices) in which there are strong They have high melting and boiling points, because a lot of energy is required to break the many strong bonds.
- When melted or dissolved in water, ionic compounds conduct electricity because the ions are free to move and carry current.

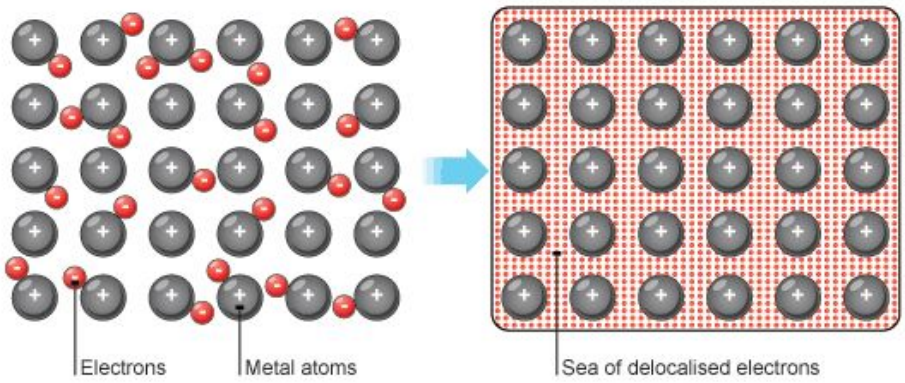
- Simple molecules
  - covalent bonding
  - Particles are atoms which share pairs of electrons
  - Occurs in most non-metallic elements and in compounds of non-metals
  - Covalently bonded substances may consist of small molecules e.g. HCl, H_2, O_2, Cl_2, NH_3, CH_4.
  - Substances that consist of simple molecules are usually gases or liquids that have low boiling and melting points.
  - Substances that consist of simple molecules have weak intermolecular forces between the molecules. These are broken in boiling or melting, not the covalent bonds.
    - The intermolecular forces increase with the size of the molecules, so larger molecules have higher melting and boiling points.
  - Substances that consist of simple molecules don't conduct electricity, because simple molecules do not have an overall electric charge.

- Giant covalent structures
  - covalent bonding (look at simple molecules)
  - Substances that consist of giant covalent structures are solids with very high melting points.
    - All of the atoms in these structures are linked to other atoms by strong covalent bonds.
    - These bonds must be overcome to melt or boil these substances.

- Polymers
  - covalent bonding (look at simple molecules)
  - Have very large molecules
  - Atoms in the polymer molecules are linked to other atoms by strong covalent bonds
  - Intermolecular forces between polymer molecules are relatively strong and so these substances are solids at room temperature

- Metals
  - metallic bonding
  - Metals consist of giant structures of atoms arranged in a regular pattern.
  - The electrons in the outer shell of metal atoms are delocalised and so are free to move through the whole structure.
  - The sharing of delocalised electrons gives rise to strong metallic bonds.
  - Metals have giant structures of atoms with strong metallic bonding.

- Therefore, most metals have high melting and boiling points.
- They can conduct heat and electricity because of the delocalised electrons in their structures.
- The layers of atoms in metals are able to slide over each other, so metals can be bent and shaped.

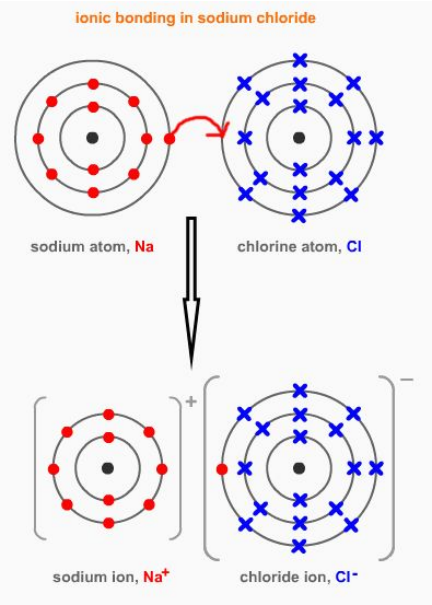


C2.2e explain chemical bonding in terms of electrostatic forces and the transfer or sharing of electrons

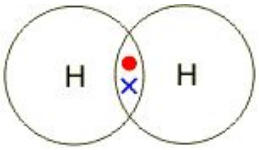
- ionic bonds: electrostatic attraction between oppositely charged ions, formed by the transfer of electrons
- covalent bonds: electrostatic attraction between a shared pair of electrons
- metallic bonds: electrostatic attraction between positive metal ions and the sea of delocalised electrons

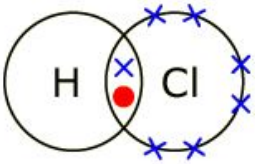
C2.2f construct dot and cross diagrams for simple covalent and binary ionic substances

- Electron transfer during the formation of an ionic compound can be represented by a dot and cross diagram (see eg for NaCl below)



- simple covalent molecules, examples of bonding:





C2.2g describe the limitations of particular representations and models to include dot and cross diagrams, ball and stick models and two- and three-dimensional representations

- dot and cross diagrams: shows how atoms are bonded and electrons, but doesn't show the 3D arrangement of molecules
- ball and stick models: show how atoms are bonded and the 3D shape, but doesn't show the electrons or the chemical symbols
- 2D/3D: generally, 2D models don't show the 3D arrangement and 3D models don't give details of bonding or electrons
- All: do not include intermolecular forces, which are the ones that are broken when boiling and melting simple molecules

C2.2h explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number

- 2, 8, 8 is the typical arrangement of electrons in shells from the first shell (closest to nucleus) outwards to the third shell
    - First shell can have up to 2 electrons
    - Second shell can have up to 8 electrons
    - Third shell can have up to 8 electrons
- All atoms will try to acquire this perfect arrangement of electrons – i.e. having the maximum number of electrons as possible in their outer shell – therefore, all atoms try to have 8 electrons in their outer shell (unless they only have one shell then they will try to have only 2) because this is the most stable arrangement
- when metals react, they are losing or gaining electrons to try and achieve the most stable arrangement of outer shell electrons

C2.2i explain in terms of atomic number how Mendeleev's arrangement was refined into the modern periodic table

- Ordered his table in order of atomic mass, but not always strictly – i.e. in some places he changed the order based on atomic weights.
- Left gaps for elements that he thought had not been discovered yet.
- Elements with properties predicted by Mendeleev were discovered and filled the gaps
- Knowledge of isotopes made it possible to explain why the order based on atomic weights was not always correct. (some elements with a smaller mass come after an element with a larger mass because they still have fewer protons)