CAIE IGCSE Chemistry

2.4 Ions and ionic bonds

Notes

Describe the formation of positive ions, known as cations, and negative ions, known as anions

- An ion is an atom or molecule with an electrical charge, due to the loss or gain of an electron
- The overall charge of an atom is zero (neutral) and the charge of an electron is negative so:
    - The gain of an electron to a non-metal results in a negative charged ion, known as an **anion**.
        - E.g. If a chlorine atom gains an electron, a chloride ion with a -1 charge is produced: $Cl + e^- \rightarrow Cl^-$
    - The loss of an electron from a metal results in a positively charged ion, known as a **cation.**
        - E.g. If a sodium atom loses an electron, a sodium ion with a +1 charge is produced: $Na \rightarrow Na^+ + e^-$

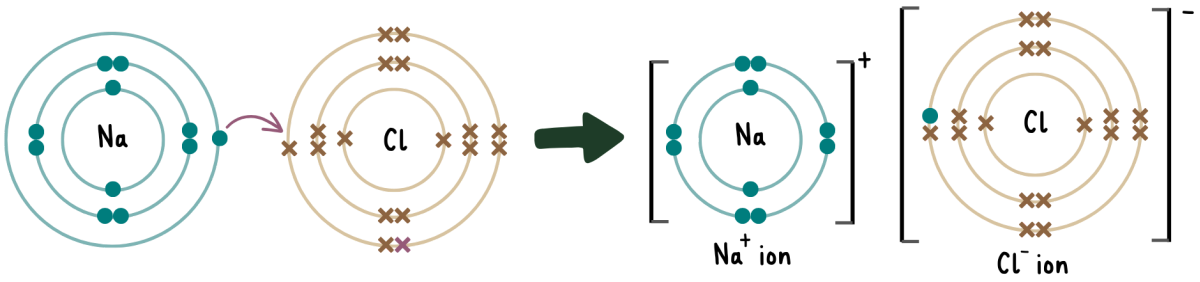
State that an ionic bond is a strong electrostatic attraction between oppositely charged ions

- Ionic bonds form between a cation and anion, this bond is a strong electrostatic attraction between the oppositely charged ions
- An electron is transferred (lost) from the cation to the anion, which gains the electron.

Describe the formation of ionic bonds between elements from Group I and Group VII, including the use of dot-and-cross diagrams

- Remember:
    - Group 1 elements (metals) have 1 outer shell electron
    - Group 7 elements (non-metals) have 7 outer shell electrons
    - So if the group 1 atom loses an electron and the group 7 atom gains an electron, the resulting ions will have full outer shells
- An ionic bond is formed between the oppositely charged ions
- A dot and cross diagram can be used to show this:
    - The 1 outer shell electron from sodium is transferred to the outer shell in chlorine
    - Since sodium lost an electron, a sodium ion with a +1 charge is formed
    - Since chlorine gained an electron, a chloride ion with a -1 charge is formed
    - Square brackets with the associated charge is used to show an ion has been made

- Use dots to represent the electrons from one element and crosses to represent the electrons from the other element
- The ions are drawn next to each other to indicate an ionic bond in the ionic compound, e.g. sodium chloride (NaCl)

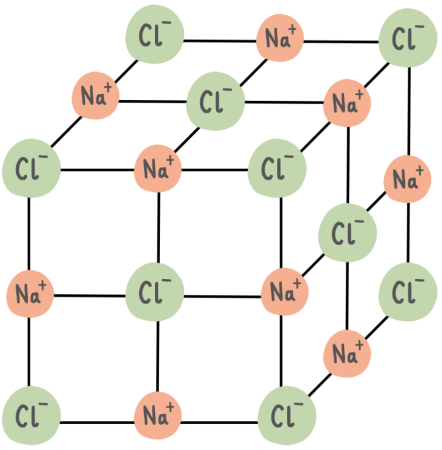


Describe the properties of ionic compounds:

Properties	Boiling point	Melting point	Electrical conductivity	
			When aqueous or molten	When solid
Ionic compounds	High	High	Good	Poor/cannot conduct

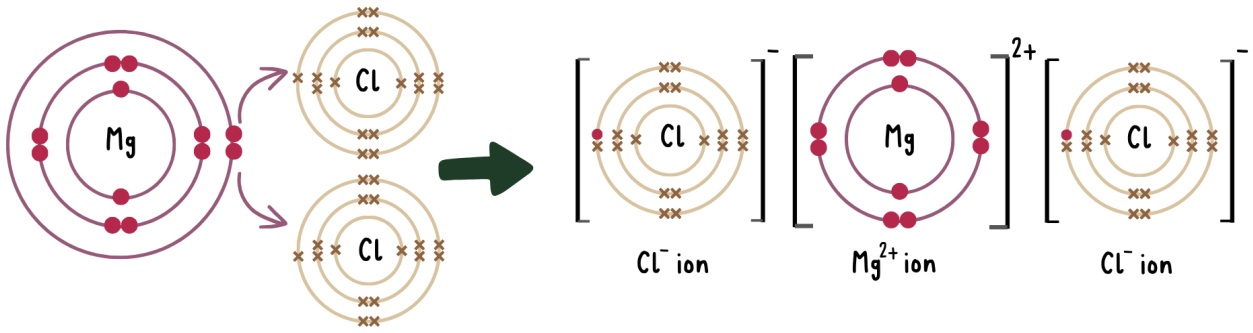
(Extended only) Describe the giant lattice structure of ionic compounds as a regular arrangement of alternating positive and negative ions

- An ionic compound has a giant lattice structure which means the cations and anions are arranged alternately
- E.g. Sodium chloride is shown in a 3D model below
- The ionic lattice is held together by strong electrostatic forces of attraction (ionic bonds) between the cations and anions



(Extended only) Describe the formation of ionic bonds between ions of metallic and non-metallic elements, including the use of dot-and-cross diagrams

- Metals lose electrons to form positively charged cations
- Non-metals gain electrons to form negatively charged anions
- E.g. Magnesium, is a group 2 metal with 2 outer shell electrons, so it must lose 2 electrons to form a magnesium ion with a +2 charge: Mg^{2+}
- E.g. Oxygen is a group 6 non-metal so it has 6 outer shell electrons, so it gains 2 electrons to form an oxide ion with a -2 charge: O^{2-}
- Dot and cross diagrams can be used to display the formation of the ionic bonds between the oppositely charged ions:
    - Magnesium must lose 2 electrons to form a full outer shell
    - Each chlorine atom must gain 1 electron to form a full outer shell
    - So 2 electrons from magnesium is transferred to each chlorine atom
    - This forms 2 chloride ions with -1 charges and a magnesium ion with a +2 charge, with ionic bonds between them



(Extended only) Explain in terms of structure and bonding the properties of ionic compounds:

- Ionic compounds have **high melting and boiling points** because the ionic bonds have very strong electrostatic forces of attraction so need more energy to overcome them.
- Ionic compounds have **good electrical conductivity when aqueous or molten**, because the ions are free to move to carry charge.
- Ionic compounds have poor electrical conductivity/ **cannot conduct electricity when solid** because the ions are fixed in position, so cannot move from one place to another.