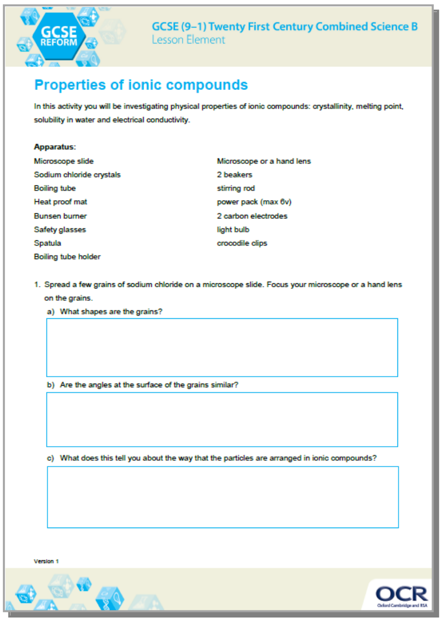
# Properties of ionic compounds

## *Instructions and answers for teachers*

***These instructions should accompany the OCR resource* 'Properties of ionic compounds'** ***activity*** *which supports OCR GCSE (9–1) Twenty First Century Combined Science B.*


GCSE (9–1) Twenty First Century Combined Science B
Lesson Element

Properties of ionic compounds

In this activity you will be investigating physical properties of ionic compounds: crystallinity, melting point, solubility in water and electrical conductivity.

Apparatus:

| | |
|---|---|
| Microscope slide | Microscope or a hand lens |
| Sodium chloride crystals | 2 beakers |
| Boiling tube | stirring rod |
| Heat proof mat | power pack (max 6v) |
| Bunsen burner | 2 carbon electrodes |
| Safety glasses | light bulb |
| Spatula | crocodile clips |
| Boiling tube holder | |

1. Spread a few grains of sodium chloride on a microscope slide. Focus your microscope or a hand lens on the grains.
   a) What shapes are the grains?
   b) Are the angles at the surface of the grains similar?
   c) What does this tell you about the way that the particles are arranged in ionic compounds?

Version 1

### Task instructions

This activity will provide students with the opportunity to investigate the properties of sodium chloride and enable several practical skills to be observed and reinforced.

After completing the ionic bonding it is a good practical task to summarise the properties of ionic compounds. The practical gives positive results for all properties studied.

PROVISIONAL

*This resource is an exemplar of the types of materials that will be provided to assist in the teaching of the new qualifications being developed for first teaching in 2016. It can be used to teach existing qualifications but may be updated in the future to reflect changes in the new qualifications. Please check the OCR website for updates and additional resources being released. We would welcome your feedback so please get in touch.*

## Teacher preparation

Low chemical risk, but be aware of heated boiling tube.

When heating sodium chloride in a boiling tube, students should point the open side of the tube away from each other.

When using a microscope, make sure students do not break the slide.

**Apparatus:**

Microscope slide
Sodium chloride crystals
Boiling tube
Heat proof mat
Bunsen burner
Safety glasses
Spatula
Boiling tube holder
Microscope or a hand lens
2 beakers
Stirring rod
Power pack (max 6v)
2 carbon electrodes
Light bulb
Crocodile clips

**Running the activity:**

1. The best way to spread a few grains of sodium chloride on a microscope slide is to use tweezers. Students should make sure that they do not touch the grains with the objectives. Sometimes is better to use a hand lens on the grains.
2. A spatula of sodium chloride is placed in a boiling tube. Tube is held by the tube holder and heated on a strong blue flame.
3. Add two spatulas of sodium chloride to half a beaker of water. Stir it with a glass rod until all salt dissolves and produces a solution.
4. Students set up a circuit as shown on the student sheet with carbon electrodes. First task is to prove that there is no electricity flowing through the solid sodium chloride. Second part is to observe the lamp lighting due to flow of current through the solution.

## Task

1. Spread a few grains of sodium chloride on a microscope slide. Focus your microscope or a hand lens on the grains.
   a) What shapes are the grains?

   Regular shape of cubic crystals.

   b) Are the angles at the surface of the grains similar?

   All angles are the same.

   c) What does this tell you about the way that the particles are arranged in ionic compounds?

   Particles are arranged in a regular order – giant lattice structure.

2. Heat some sodium chloride crystals strongly in a boiling tube.
   a) What can you conclude about the melting point of this ionic compound?

   Melting point is very high.
   Extended answer: A great deal of energy is needed to break down the lattice structure

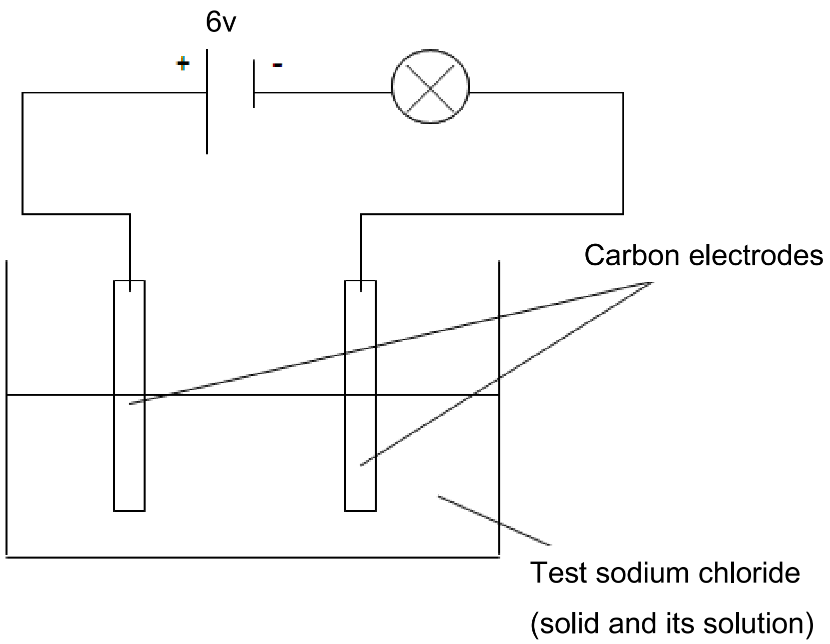
   b) What does this suggest about the strength of ionic bonds?

   The oppositely charged ions are attracted to each other by strong forces. Ionic bonds are strong bonds.

3. Add two spatulas of sodium chloride to half a beaker of water. Stir it with a glass rod.
   a) What happens? Explain.

   Sodium chloride dissolves in water due to water being a dipole. Positive part of the water molecule separates the negative chloride ion from the positive sodium ion in the lattice. Sodium ion is surrounded by the negative part of the water molecule being pulled away from the lattice. The lattice breaks up and the ions mix in with water molecules – the substance dissolves.

4. Set up a circuit as shown:




Dip carbon electrodes into some solid sodium chloride.

a) Does the solid conduct electricity?

It does not.

5. Now take the electrodes out. Half-fill the beaker with water and stir.

a) Does the light bulb light up now? Explain.

The bulb lights up due to ions of sodium and chloride being free to move and the solution conducts electricity.

b) What do your results tell you about the nature of the particles present in ionic compounds?

Ions of sodium and chloride when solid are not able to move, so the solid salt does not conduct electricity. When dissolved, ions become free to move and conduct electricity.

## Ionic bonding homework sheet

1. Why is sodium chloride called an ionic compound?

It contains oppositely charged ions.

2. If sodium chloride contains millions of positive sodium ions and millions of negative chloride ions, why is a crystal of sodium chloride electrically neutral?

Positive and negative ions cancel each other out.

3. Why is it difficult to separate sodium from chlorine in sodium chloride?

The forces of attraction between the oppositely charged ions are very strong.

4. Why are sodium ions and chloride ions stable?

They have 8 electrons on their outer shell (full outer shell).

5. Why has sodium chloride got a high melting point?

There is a lot of energy needed to break the strong ionic bonds within the ionic lattice.

6. The formula of magnesium chloride is $MgCl_2$. Draw dot and cross diagrams to show how one magnesium atom and two chlorine atoms come together to make magnesium chloride.

Students should clearly show a transfer of two electrons from magnesium atom to two atoms of chlorine to form two 1- chloride ions (showing 8 electrons on its outer shell in the bracket, one electron is different, either dot or a cross) and one 2+ magnesium ion.

7. Draw dot and cross diagrams showing only the electrons on the outer shell to explain the formation of each of the following ionic compounds. In each case state the formula of the compound:

   a) aluminium fluoride

Transfer of 3 electrons from aluminium to three fluorine atoms to form three 1- fluoride ion showing electrons on their outer shell inside a square bracket and one 3+ aluminium ion.

   b) sodium oxide

Two sodium atoms transfer one electron each to one oxygen atom to form two 1+ sodium ions and one 2- oxide ion (show outer electrons in the square bracket).

c) lithium sulphide

Two lithium atoms transfer one electron each to one sulfur atom to form two 1+ lithium ions and one 2- sulfide ion (show outer electrons in the square bracket).

8. What kind of ions are formed by:

a) Group 1 elements?

1+ ions.

b) Group 2 elements?

2+ ions.

c) Group 7 elements?

1- ions.

d) Group 6 elements?

2- ions.

9. State the number of protons, neutrons and electrons in each of the following ions (use the information from the Periodic Table):

| | $Li^{+}$ | $F^{-}$ | $Ca^{2+}$ | $S^{2-}$ | $Al^{3+}$ |
|---|---|---|---|---|---|
| protons | 3 | 9 | 20 | 16 | 13 |
| electrons | 2 | 10 | 18 | 18 | 10 |
| neutrons | 4 | 10 | 20 | 16 | 14 |

10. State the formula of the compound caesium iodide.

CsI

## Ionic bonding – Summary

When a [metal] reacts with a [non-metal] an ionic bond is formed.

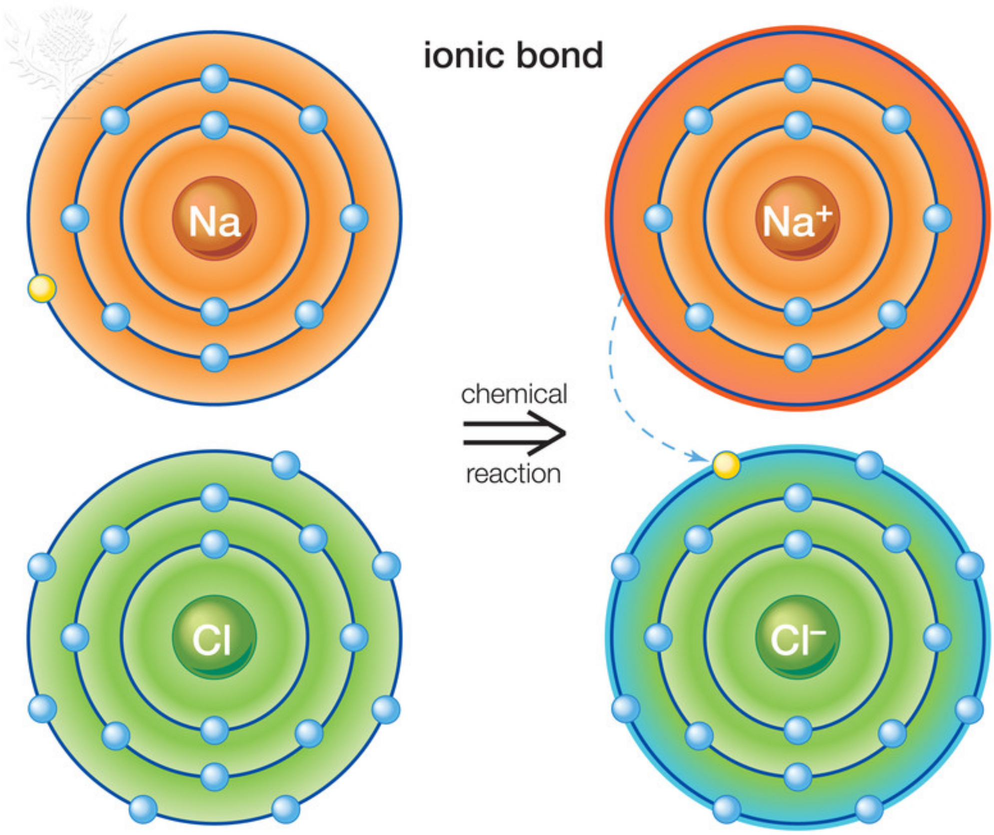
Example [sodium] + [chlorine] → [sodium chloride]

The metal atom [loses] electrons and becomes [positively] charged ion.

The lost electrons are transferred to [non-metal] and it becomes [negatively] charged ion. Consider the reaction between sodium and chlorine.

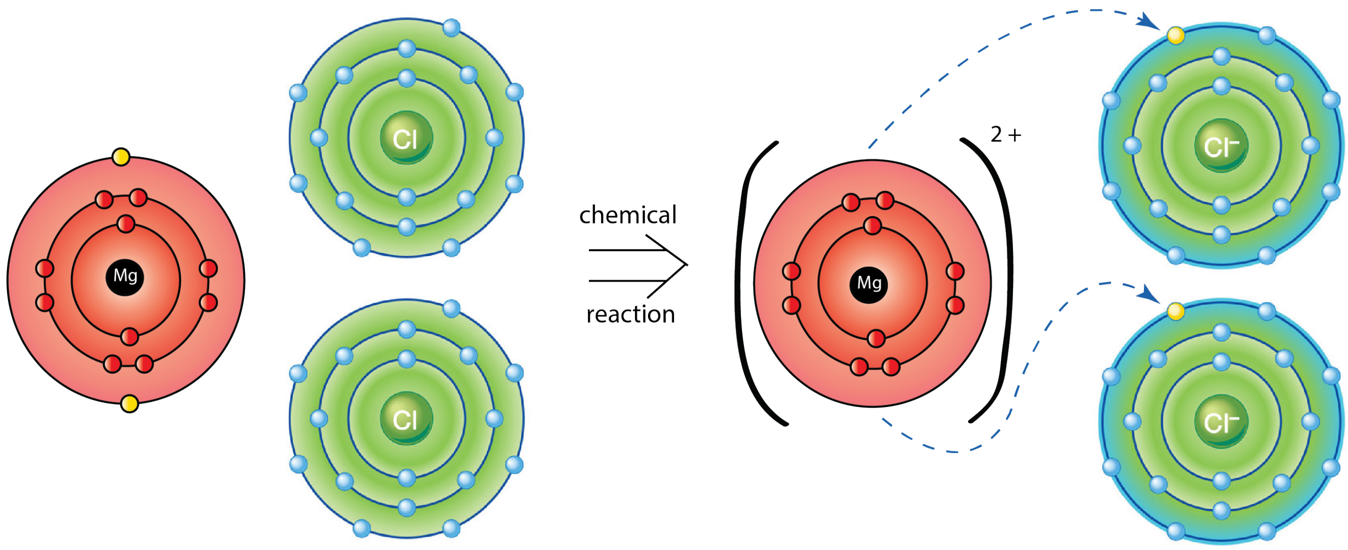
Draw dot and cross diagram to represent atoms and ions of reacting elements:

sodium atom + chlorine atom —REACTION→ sodium chloride



The single [electron] in the outer level (shell) [energy] of the sodium atom has been transferred to the [chlorine] atom. The sodium formed is [chloride] held together by the strong [attraction] between the sodium [ion] and the chloride [ion]. A lot of [energy] is given out due to the energy released when the strong [ionic] bonding between the ions is formed.

Now draw dot and cross diagram to represent the reaction between magnesium and chlorine. Note that you need two chlorine atoms to react with one magnesium atom.



Ions do not exist in isolation. The ions are arranged in huge networks in a regular giant ionic structure called [lattice] structure. The lattice is held together by the strong [attraction] between the positively and negatively [charged] ions. The ionic bond is a force of [attraction] between the oppositely charged ions. A great amount of energy is required to break down the lattice and [ions] form and that is why in general [ionic] compounds have melting and [high] boiling points. Ionic compounds tend to be [chrystalline] due to the regular arrangement of ions in the lattice. They are often soluble in water. Ionic compounds conduct electricity when [molten] or [dissolved] in water. This happens because the [ions] become free to move around.