

1f - Ionic bonding

Edexcel IGCSE Chemistry Revision Notes

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How to use these notes

These notes cover everything you need to know for this part of the specification. They have been written in question-answer format to make them easier for you to study from.

In order to study successfully, I recommend you do the following for each question and answer:

- Read it carefully and make sure you **understand** it.
- **Memorise** the answer.
- **Practice** applying your understanding to past exam questions.

A good way to memorise information is to use **retrieval practice**. This is when you practise retrieving information from your memory. You could do this by making a flashcard for each question with the question on one side and the answer on the other. Or you could use a flashcard app. Alternatively, use a sheet of paper to cover up the answer so you can only see the question. Try to answer the question and then check how you did.

You should practise retrieving each answer from your memory until you can do it perfectly. Even once you can retrieve the answer perfectly, your ability to retrieve it will probably fade as time passes without practising. Therefore you will need to keep going back to the questions that you have previously mastered and practising them again. However, each time you re-learn the answer, the memory will be stronger and will last longer than the time before.

1.37

How can an atom turn into an ion?

An atom can turn into an ion by gaining or losing electrons.

What type of ion does an atom turn into when it gains electrons?

When an atom gains electrons it turns into an anion (negatively charged ion).

What type of ion does an atom turn into when it loses electrons?

When an atom gains electrons it turns into a cation (positively charged ion).

1.38

Metals in group 1 usually form ions with what charge?

Metals in group 1 usually form ions with a charge of +1.

Metals in group 2 usually form ions with what charge?

Metals in group 2 usually form ions with a charge of +2.

Metals in group 3 usually form ions with what charge?

Metals in group 3 usually form ions with a charge of +2.

Non-metals in group 5 usually form ions with what charge?

Non-metals in group 5 usually form ions with a charge of -3.

Non-metals in group 6 usually form ions with what charge?

Non-metals in group 6 usually form ions with a charge of -2.

Non-metals in group 7 usually form ions with what charge?

Non-metals in group 7 usually form ions with a charge of -1.

Note: Names of negatively charged ions

When an ion of an element is negatively charged (e.g. P^{3-} , O^{2-} , Cl^-), the ending of the element's name is usually changed to '-ide' in the name of the ion.

For example:

- P^{3-} is called a 'phosphide ion' (not a 'phosphorus ion')
- O^{2-} is called an 'oxide ion' (not an 'oxygen ion')
- Cl^- is called a 'chloride ion' (not a 'chlorine ion')

If the ion is positively charged, the name of the element is unchanged. For example, Na^+ is called a 'sodium ion'.

Silver usually forms ions with what charge? What is the formula of these ions?

Silver usually forms ions with a charge of +1. The formula of these ions is Ag^+ .

Copper usually forms ions with what charge? What is the formula of these ions?

Copper usually forms ions with a charge of +2. The formula of these ions is Cu^{2+} .

Beyond the syllabus: Copper ions

Copper also sometimes forms ions with a charge of +1. These have the formula Cu^+ . However, you do not need to know about these ions for this course.

What two different types of ions can iron form?

Iron sometimes forms ions with a charge of +2. These have the formula Fe^{2+} .

Iron sometimes forms ions with a charge of +3. These have the formula Fe^{3+} .

Lead usually forms ions with what charge? What is the formula of these ions?

Lead usually forms ions with a charge of +2. The formula of these ions is Pb^{2+} .

Zinc usually forms ions with what charge? What is the formula of these ions?

Zinc usually forms ions with a charge of +2. The formula of these ions is Zn^{2+} .

What is the formula of a hydrogen ion?

The formula of a hydrogen ion is H^+ .

What is the formula of a hydroxide ion?

The formula of a hydroxide ion is OH^- .

What is the formula of an ammonium ion?

The formula of an ammonium ion is NH_4^+ .

Revision Tip: Ammonium vs ammonia

Don't confuse the ammonium ion with the molecule ammonia.

The ammonium ion has the formula NH_4^+ .

Ammonia has the formula NH_3 .

What is the formula of a carbonate ion?

The formula of a carbonate ion is CO_3^{2-} .

What is the formula of a nitrate ion?

The formula of a nitrate ion is NO_3^- .

What is the formula of a sulfate ion?

The formula of a sulfate ion is SO_4^{2-} .

1.39

What is the term for a positively charged ion?

A positively charged ion is called a 'cation'.

What is the term for a negatively charged ion?

A negatively charged ion is called an 'anion'.

What is every ionic compound made up of?

Every ionic compound is made up of a cation and an anion.

How are ionic compounds named?

The name of an ionic compound is always made up of the name of the cation followed by the name of the anion.

Examples: Names of ionic compounds

If we are given the name of an ionic compound, we can easily work out the name of the cation and the name of the anion, because the name of the cation always comes before the name of the anion in the name of the compound.

For example:

- In ammonium chloride, the cation is ammonium and the anion is chloride.
- In potassium sulfate, the cation is potassium and the anion is sulfate
- In iron (III) oxide, the cation is iron (III) and the anion is oxide.

How can you work out the formula of an ion from its name?

How you work out the formula of an ion from its name depends on what the ion is:

- If it is an ion of an element in Groups 1, 2, 3, 5, or 6, then you can work out its charge based on its group number and use this to write the ion's formula.
- If it is an ion of an element not in any of those groups, there will be a number in roman numerals in brackets after the name of the element. This number is the charge of the ion (note: these ions are always positively charged).
- If the ion is hydroxide, ammonium, carbonate, nitrate or sulfate, then you have to have its formula memorised.

How do you work out the formula of an ionic compound from its name?

To work out the formula of an ionic compound from its name, use the following steps:

- First, identify the name of the cation and the name of the anion.
- Then, work out the formula of the cation and the formula of the anion.
- By looking at the charges of the cation and the anion, work out what ratio they need to be in for the overall charge to be 0 (neutral). Make sure you use the smallest whole-number version of the ratio (e.g. 2:3 not 4:6).
- Write the formula of the compound using this ratio.

Examples: Working out the formulae of ionic compounds

Here are some example questions for working out the formulae of ionic compounds:

QUESTION 1: Write down the chemical formula of calcium fluoride.

The first step is to identify the cation and the anion:

Cation: Calcium

Anion: Fluoride

Next we have to work out the formula of each ion.

Calcium is an element in Group 2, so the calcium ion will have a charge of +2.

Fluorine is an element in Group 7, so the fluoride ion will have a charge of -1.

Combining the charges with the chemical symbols of the elements, gives the formula of the ions:

Cation: Calcium - Ca^{2+}

Anion: Fluoride - F^-

In order for the compound to be neutral we need a 1:2 ratio of calcium ions to fluoride ions. This is because one calcium ion has a charge of +2 and two fluorine ions together have a charge of -2, so they add together to make 0.

Therefore, the formula of calcium fluoride is:

CaF_2

QUESTION 2: Write down the chemical formula of iron (III) oxide.

First, we name the cation and the anion:

Cation: Iron (III)

Anion: Oxide

The 'III' in brackets is roman numerals for the number 3. This tells us that the iron (III) ion has a charge of +3.

Oxide is an ion of oxygen, which is in Group 6. Therefore it has a charge of -2.

Cation: Iron (III) - Fe^{3+}

Anion: Oxide - O^{2-}

To balance the charges, we need a 2:3 ratio of iron (III) ions to oxide ions. This is because two iron (III) ions together have a charge of +6 and three oxide ions together have a charge of -6, so they add together to make 0.

Therefore, the formula of iron (III) oxide is:



QUESTION 3: Write down the chemical formula of magnesium nitrate.

First, name the cation and the anion:

Cation: Magnesium

Anion: Nitrate

Magnesium is in Group 2, so the magnesium ion has a charge of +2.

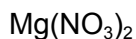
Nitrate is one of the ions that we have to memorise the formula of. Its formula is NO_3^- .

Cation: Magnesium - Mg^{2+}

Anion: Nitrate - NO_3^-

We need a 1:2 ratio of magnesium to nitrate in order to balance the charges.

Therefore, the formula of magnesium nitrate is:



Note that we put the formula of the nitrate ion in brackets because we want the number 2 to apply to the whole of the nitrate ion.

1.40

How do you draw a dot and cross diagram for an atom?

To draw a dot and cross diagram for an atom, start by writing the chemical symbol of the atom's element. Then draw crosses around the chemical symbol to represent the electrons in the outer shell.

How do you draw a dot and cross diagram for a cation (positive ion)?

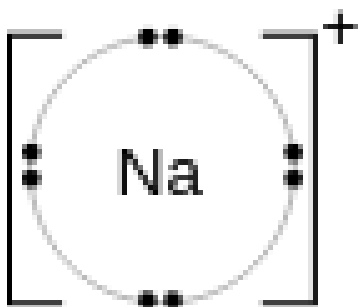
To draw a dot and cross diagram, follow the same steps as drawing a dot and cross diagram for an atom, and then draw square brackets around the diagram and write the ion's charge in the upper right corner.

How do you draw a dot and cross diagram for an anion (negative ion)?

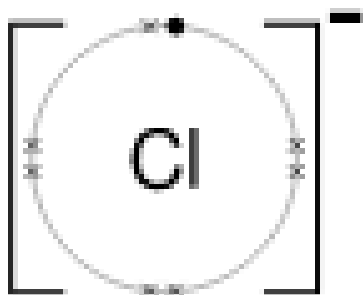
To draw a dot and cross diagram for an anion, follow the same steps as you would for a cation, but use a mixture of crosses and dots to show how the ion could have formed from an atom. Use crosses for the electrons that would have been present in the original atom and dots for the electrons that would have been gained to form the ion.

Examples: Dot and cross diagrams of ions

Sodium ion (a cation):



Chloride ion (an anion):



How do you draw a dot and cross diagram to show the formation of an ionic compound from atoms?

To draw a dot and cross diagram to show the formation of an ionic compound from atoms, first draw dot and cross diagrams of the two types of atom that would react to form the compound. Then, below that, draw the two ions that would be formed next to each other.

1.41

What holds the ions together in an ionic bond?

In an ionic bond, the ions are held together by electrostatic attraction. An ionic bond always involves a positively charged ion (cation) and a negatively charged ion (anion). Because they have opposite charges, there are forces of electrostatic attraction between them and these forces hold the ions together.

1.42

What type of structure do ionic compounds have?

Ionic compounds have a giant ionic lattice structure. This means that they are made up of a large number of ions arranged in a repeating pattern.

Why do compounds with giant ionic lattice structures have high melting and boiling points?

Compounds with giant ionic lattice structures have high melting and boiling points because in order to melt or boil them it is necessary to separate all of the ions, which involves breaking all of the strong ionic bonds between them, which requires a large input of energy.

1.43

Under what conditions do ionic compounds conduct electricity?

Ionic compounds conduct electricity when they are molten (liquid) or when they are in aqueous solution (dissolved in water). They do not conduct electricity when they are solid.