# BBC Bitesize - Chemistry

# Episode 1 – Ionic bonding

**TULELA:** I'm Tulela Pea, a science communicator and podcaster.

**SUNAYANA:** And I'm Dr Sunayana Bhargava, scientist and poet.

**TULELA:** And this is Bitesize Chemistry. Hello lovely podcast listening friends. We're back with all things GCSE Chemistry and combined science. Good to see you again, Sunayana.

**SUNAYANA:** You too, my friend – especially seeing as we seem to be getting on so well in series one.

**TULELA:** Yes, we definitely bonded.

**SUNAYANA:** Is that a clue as to what this series is all about?

**TULELA:** Yep, you got it! Together, over the next eight episodes, we'll be looking at the key concepts of bonding, structure and properties of molecules and compounds in chemistry.

**SUNAYANA:** With some real-world examples, some analogies to help us understand the ideas in different ways and we'll round off each episode with a quick quiz and the key facts to remember.

**TULELA:** Can't wait, Sunayana. Let's do it.

**SUNAYANA:** In this series, we'll be focussing on different ways that atoms are bonded together and how the structure and properties of these compounds differ, depending on the way in which they are bonded. So, let's look at why bonding is so important in chemistry.

**TULELA:** Well, simply without bonding, there is no chemistry.

**SUNAYANA:** So, you're saying no molecules or compounds, which means no water, no carbon dioxide - which almost certainly means no life.

**TULELA:** Sure, but it's worse than that, we'd have no stable structure at all. The universe without chemical bonding would be boring and lifeless forever.

**SUNAYANA:** Let's get some background. We're joined again NNICK. NNICK, can you give us some background on the different types of chemical bonding?

**NNICK:** Bonds. Chemical bonds. [EMOTIONAL MUSIC] Is there any stronger bond than that between a she-wolf and her pup? Or a she-moose and her calf? Or a she-hamster and her… calf? Yes. There are at least three stronger bonds, actually: ionic bonding, covalent bonding and metallic bonding.

Ionic bonds form in compounds between a metal and a non-metal. Electrons are transferred from the metal atom, which becomes a positive ion, to the non-metal atom, which becomes a negative ion. The ions are strongly attracted to one another. But it's an electrostatic attraction – no funny business. Ionic bonds are very, very, very, very, very, very, very, very strong.

**SUNAYANA:** Thanks, NNICK. Let's unpack that a bit.

**TULELA:** Ionic means that the atoms involved in these compounds become ions. And the ionic bond is the force between those two oppositely charged ions to form a compound – it's called an electrostatic force – so that each of the atoms in the compound has that stable full outer shell of electrons.

**SUNAYANA:** This ionic bonding occurs between metals such as those found in groups 1 and 2 of the periodic table and non-metals.

**TULELA:** Group 1 elements have one electron in their outer shell which they want to get rid of so they become positively charged 1+ ions when they lose that negatively charged electron. Group 2 elements have two electrons in their outer shell and so become 2+ ions when they lose their outer shell electrons. Positively charged ions are called cations.

**SUNAYANA:** A good way to think about how losing something - in this case, electrons - can make it more positive, is if you have a cold bug, which is a negative thing to have and then imagine you lose that bug and feel better, feel more positive.

For example, sodium in group 1 loses an electron to become sodium plus ion. Magnesium in group 2 loses two electrons to become magnesium plus 2 ion.

**TULELA:** The non-metals involved in ionic bonding are in groups 6 and 7. The group 6 elements are two electrons short of a full shell and so they want to receive extra electrons to complete their shell, and group 7 are one short.

**SUNAYANA:** So, when those atoms receive electrons to complete a full outer shell, they become negative ions. So, for example, oxygen in group 6 gains two electrons to become oxide 2 minus ion and chlorine in group 7 gains one electron to become chloride 1 minus ion. Negatively charged ions are called anions.

**TULELA:** Sunayana, we keep talking about atoms wanting to lose or wanting to gain electrons because they want to have a complete outer shell. But they don't really want anything? Atoms don't think anything.

**SUNAYANA:** Of course not. I suppose this is just a convenient way that we humans like to think about what's going on. In reality, atoms are simply much more stable in compounds when they have a full outer shell. It's like saying that a chair is more stable when it has four legs rather than three legs. We wouldn't say that the chair wants an extra leg. But saying that an atom wants to lose an electron is just a nice way that we can imagine it.

**SUNAYANA:** Tulela, fancy some ionic bond examples to try out?

**TULELA:** Go for it.

**SUNAYANA:** Let's start with a nice easy one – our good old friend table salt, sodium chloride or NaCl.

**TULELA:** Ok, sodium is in group 1 so has one electron in its outer shell. Chlorine is in group 7, so wants – or is more stable with - an electron to complete its outer shell. Sodium gives up its electron and becomes sodium plus ion. Chlorine receives that electron and becomes chloride minus ion. So an electron is transferred from sodium to chlorine - and since oppositely charged ions are attracted to each other through the electrostatic force, they become bonded. The ionic bond. How about magnesium chloride?

**SUNAYANA:** OK, magnesium is in group 2 so has two outer shell electrons. Chlorine we've already said is in group 7, so wants just one of those electrons. So, in this case one magnesium atom donates its two electrons to become magnesium 2 plus ion. And two chlorine atoms take one each of those electrons and both become chloride minus ions. So, the compound is Mg-Cl2 which means one magnesium atom and two chlorines. And again, the electrostatic attractions between the magnesium ion and the two chloride ions are the ionic bonds. Final example – sodium oxide.

**TULELA:** We'll go through this one in a moment, but if you want to have a go yourself, press pause now whilst we look at some cat pictures on social media.

**SUNAYANA:** Ahhh… look at that one…

**TULELA:** Sweet, right?

OK, we're back. So, sodium oxide: sodium, group 1, one outer shell electron. Oxygen, group 6, needs two outer shell electrons. So, in this case two sodium atoms each give up their electron, each becoming sodium – or Na plus – ion. The oxygen picks up the two electrons and becomes oxide or O 2 minus, and the compound is therefore Na2-O.

**SUNAYANA:** It can be useful to draw a diagram to describe what's going on in these ionic bond formations, to show the outer shell arrangement of electrons in the metals and non-metals before and after the transfer of electrons. You can find some useful diagrams of these on the Bitesize website.

**TULELA:** You may have seen dot and cross diagrams where we draw dots to represent the outer shell electrons of one ion and crosses for outer shell electrons of the other. Doesn't matter which, as long as its dots for one and crosses for the other. So, for example, we'd draw one dot for sodium's only outer shell electron, or two for magnesium's outer shell electrons.

**SUNAYANA:** And the electrons in the non-metal outer shell we'd then represent by crosses. So 6 for oxygen and 7 for chlorine. Again, we're just interested in what's happening with outer shell electrons so we'll only draw them, rather than all the electrons in all the shells.

**TULELA:** We draw arrows showing that the dots – the metal electrons - are transferred to the outer shell of the non-metal to join with the crosses. In an exam, you need to draw square brackets around the ions that are formed – you can find examples of these on the Bitesize website.

**SUNAYANA:** Time for a quick Summary, Tulela?

**TULELA:** Start us off.

**SUNAYANA:** Bonding is important in chemistry, as that's the process where molecules and compounds form.

**TULELA:** Ionic bonding takes place in compounds made from metals and non-metals so that the outer shells are completed in the atoms.

**SUNAYANA:** The metals lose electrons to become positively charged ions.

**TULELA:** And the non-metals gain electrons to become negatively charged ions.

**SUNAYANA:** Dot and cross diagrams are a useful way to represent this.

**TULELA:** The next episode is more on ionic compounds, looking at their structure and properties.

**SUNAYANA:** And don't worry as I'll be here too - don't want to break that bond now do we, Tulela?

**TULELA:** See ya.

**SUNAYANA:** See ya.