BBC Bitesize - Chemistry

Episode 8 – Groups in the periodic table

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. In this final episode of an eight-part series on atomic structure and the periodic table, we're going to look at three groups in periodic table – specifically group 1, group 7 and group 0.

SUNAYANA: As always, it might be handy to write some notes or diagrams along the way so hit pause when you need to. Don't worry, we'll still wait for you to hit play again.

TULELA: For this episode, it might be useful if you have a periodic table to hand in front of you.

SUNAYANA: Or if you have an amazing photographic memory. But before we delve into the properties of the elements in those groups, let's have a quick reminder of why those atoms belong to those particular groups in the first place. Hi, NNICK. Please can you give us a summary of groups 1, 7 and 0?

NNICK: Groups are the vertical columns of the periodic table, running from 1-7 and finishing with 0. Don't ask me why, it's just a very human way of numbering things.

Group 1 are the alkali metals, so called because they are metals and because they react with water to form an alkaline solution. In chemical reactions, these alkali metals give away an electron.

Group 7 are the halogens, so called because they are halogens. In chemical reactions, these non-metals gain an electron to complete their electron shell.

And group 0 are the noble gases. Because their outer electron shell is already full, it is stable and the elements do not take part in chemical reactions. They are inert. How these gases can call themselves noble, I'll never know.

TULELA: Thanks NNICK! We'll start with group 1 then. These are all the elements with one electron in the outer shell of the atom. Lithium, sodium, potassium, rubidium and caesium. These are known as the alkali metals and the further down the group the element sits in the table, the more reactive it is.

SUNAYANA: And this is because of that single electron in each of the element's outer-shell. The further down group 1, the further away the outer shell's electron is from the nucleus. The more electron shells there are shielding the positive charge of the nucleus from the outer electron.

TULELA: This means that the outer shell electron is less strongly attracted to the positively charged nucleus and so less energy is needed to remove it. This increasing reactivity becomes really clear when those alkali metals are put into water.

SUNAYANA: As we go down the group, the more reactive the metal is in water. Lithium, for example, will move around the surface, fizzing away until it disappears. Sodium and potassium do the same but progressively faster than lithium and also they melt away. In all three reactions, hydrogen is made and released and this can be tested for and will pop in the presence of a burning splint. You may have heard this called the "squeaky pop test". [POP]

TULELA: In fact, the potassium reaction with water is so vigorous that the hydrogen ignites spontaneously.

SUNAYANA: As well as hydrogen, the other product produced in each of these reactions is the hydroxide OH of these metals. For example, sodium hydroxide or potassium hydroxide.

TULELA: And when we test this with a universal indicator, the solution turns purple showing the presence of an alkali – which is why group 1 metals are called the alkali metals.

SUNAYANA: Makes perfect sense.

TULELA: That's group 1, the alkali metals. Now, onto group 7. These are known as the halogens and include fluorine, chlorine, bromine and iodine – all with seven electrons in their outer shell. And because they are in the same group, they also have similar chemical properties.

SUNAYANA: They are all non-metals and exist as molecules of two atoms. So Cl2, Br2, I2 for example. As each element is one electron short of a full outer-shell, two atoms are needed to share one pair of electrons to get a full outer shell across the two-atom molecule. And there'll be more of this sharing type bonding – covalent bonding – in series two.

TULELA: The further down group 7 the halogen element is, the higher its relative molecular mass, melting point and boiling point and the darker the element becomes. So, at room temperature, fluorine, a yellow gas, chlorine a green gas. Bromine is a red-brown liquid or orange vapour and iodine is a grey solid or purple vapour.

SUNAYANA: And as we go down the group of halogens, the reactivity of the element decreases. This is the opposite of what we saw with the alkali metals in group 1. And this is again due to how the electrons are arranged in the outer shell of the atom. The further down the group, the further away the outer-shell electrons are from the positively charged nucleus and so the harder is it for the atom to attract that extra negatively-charged electron to fill the outer shell.

TULELA: We can see this when halogens react with metals, for example the alkali metals with one electron in their outer shell. Those higher in the halogen group react more vigorously because they attract that outer shell electron from the metal atom more easily. And in each case the resulting compound produced is a salt – in this case called a metal halide.

SUNAYANA: So, for example, chlorine will react vigorously with sodium to produce the salt, or metal halide, sodium chloride.

TULELA: But if a more reactive halogen comes along, it can displace a less reactive halogen from solutions of its salts.

SUNAYANA: So for example, let's say we have a solution of potassium bromide and we add chlorine solution. Chlorine is a more reactive halogen so will displace bromine to form potassium chloride.

TULELA: Yes – I like to imagine a pool party with groups friends in pairs chatting to each other – one a halogen and one an alkali metal. So it's as if potassium and bromine are having a nice catch-up in one corner of the pool but along comes chlorine and displaces bromine who just swims off.

SUNAYANA: Shame – poor bromine. So halogens react with alkali metals to form metal halides and more reactive halogens displace less reactive ones

TULELA: And when the halogens react with hydrogen they form compounds called hydrogen halides which all dissolve in water to form acids. For example HCl or hydrogen chloride which dissolves in water to form hydrochloric acid.

SUNAYANA: Finally, there's one last group we need to talk about – they're the noble gases – helium, neon, argon, krypton and xenon in group 0.

TULELA: The noble gases have all got a full complete outer-shell of electrons and so are already quite stable on their own without requiring to gain or lose extra electrons. This also means that they exist as single atoms, unlike those halogens who need to pair up to form stable molecules.

As we travel down group 0 in the periodic table, the boiling point and density of the noble gases increase. And although they are inert, the noble gases have their uses. Helium is used in airships because it is less dense than air. Argon is used to protect metals being welded and the noble gases also give off light when an electric current is passed through them.

SUNAYANA: That's group 1, group 7 and group 0 taken care of but if you're doing triple science then you also need to know about the transition metals which sit in the middle of the periodic table between group 2 and group 3.

TULELA: They include lots of the everyday metals you may have heard of, including copper, iron, zinc, gold and silver. Although they have the same typical properties as all other metals – they conduct electricity and are shiny when cut – they tend to be more colourful and have other different properties to those we've seen in the alkali metals in group 1. You can find out more about these on the Bitesize website.

TULELA: How about a quiz about group 1,7 and 0?

SUNAYANA: Yes, please.

TULELA: As usual, three questions, five seconds each starting ….now. Question 1. In group 1 how does the reactivity of alkali metals change as we go down the group?

SUNAYANA: They get increasingly more reactive because less energy is needed to remove the outer shell electron from the alkali metal.

TULELA: Question 2. Chlorine is higher in group 7 than iodine. If I have a solution of potassium iodide and add chlorine to the solution, what happens?

SUNAYANA: The chlorine displaces the iodine to form potassium chloride.

TULELA: And question 3. Why are the noble gases so unreactive?

SUNAYANA: Because they have a full outer shell of electrons.

TULELA: Correct, correct and correct. Hope you did the same but don't worry if you didn't as there's loads more hints, tips, diagrams and revision notes over at the BBC Bitesize website.

SUNAYANA: Quick summary blitz, Tulela?

TULELA: Lets go. Group 1 elements are the alkali metals, they have one electron in their outer shell and become more reactive the further down the group.

SUNAYANA: Group 7 elements are the halogens. They are one electron short of a full outer shell and become less reactive further down the group.

TULELA: Group 0 are the noble gases and they have full outer shells and so are inert or unreactive.

SUNAYANA: And for those of you doing triple science, remember those useful and colourful transition metals.

TULELA: Thanks for listening and remember you can listen on BBC Sounds to all the other episodes in this series, as well as many other Bitesize subjects.

SUNAYANA: In the next series, we'll be looking at bonding in chemistry and how this affects the structure and properties of elements and compounds.

TULELA: Thanks for listening to this series.

SUNAYANA: Bye.