BBC Bitesize – Chemistry

Episode 2 – The reactivity series of metals

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

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

SUNAYANA: And this is Bitesize Chemistry. This is the second episode in an eight-part series on chemical changes.

TULELA: In this episode, we're going to be looking at the reactivity series of metals, their reaction with acids and water and how a more reactive metal can replace a less reactive one from a compound.

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

TULELA: And also hit rewind if you need to go over some of those key facts. And remember to head over to BBC Bitesize on the web for more useful information and diagrams.

SUNAYANA: So before we delve a little deeper into what makes one metal more reactive than another, let's look at why it's so important to know about the reactivity of metals anyway.

TULELA: Well for one, knowledge of the reactivity series helps us to select appropriate materials for specific applications. For example, using a less reactive metal in a corrosive environment can extend the lifespan of a structure. And there are loads of other everyday examples of how it helps us to make informed decisions about what materials to use.

SUNAYANA: Let's get a little background on this from our binary banter-bot NNICK. Hi NNICK, can you give a summary about the reactivity series of metals?

NNICK: The reactivity series of metals is a list of metals showing how reactive they are in comparison to one another. It's a bit like a football league table for metals – except without the football teams, the promotions, the relegations or the blubbing.

When metals react with other substances, they lose electrons to form positive ions. Reactive metals lose their electrons easily. Less reactive metals don't give up their electrons as easily, and so react with other elements more slowly, or not at all.

SONG

NNICK: Dear reactive metal, would you love to give your electrons away?

REACTIVE METAL: Wa hey!

NNICK: I'll take that as a yes.

Dear reactive metal, your chemical reactions are vigorous. Is that true?

REACTIVE METAL: Woo hoo!

NNICK: I'll take that as a yes.

Dear unreactive metal, would you love to let your electrons go?

UNREACTIVE METAL: No.

NNICK: I'll take that as a no.

Dear unreactive metal, do your chemical reactions go rapidly?

UNREACTIVE METAL: No.

NNICK: I'll take that as a no.

Dear reactive metal, are you at the top of the reactivity series?

REACTIVE METAL: Yippee!

NNICK: I'll take that as a yes.

Dear unreactive metal, are you at the top of the reactivity series?

UNREACTIVE METAL: No.

NNICK: Shall I take that as a no?

UNREACTIVE METAL: Er…y…yes?

TULELA: Thanks NNICK. So, the reactivity of a metal, or how vigorously it reacts, is related to its tendency to lose its outer shell electrons and form positive ions.

SUNAYANA: Cations.

TULELA: Correct – cations. The more reactive, the easier it forms cations and the higher in the series. The less reactive, the lower in the series.

SUNAYANA: Some versions of the reactivity series include more metals than others but the metals are always in the same place relative to each other. A typical one might include potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper.

TULELA: And sometimes hydrogen and carbon are included even though they are non-metals as it helps us compare just how reactive the metals are. And we'll see why this is useful in the episodes on metal extraction and electrolysis.

SUNAYANA: It might be useful to press pause and look at the reactivity series on the Bitesize website for the next section.

SUNAYANA: So how do we go about creating the list, I hear you ask.

PAUSE

SUNAYANA: I said, I hear you ask.

TULELA: Sorry – how do we go about creating the list, Sunayana?

SUNAYANA: Thanks! Well, we can compare how each of the metals reacts with water or a dilute acid.

TULELA: Let's take that list from before. And if we add a small piece of each metal in turn into a test tube with dilute hydrochloric acid we'll see that those at the top of the list, the most reactive metals like potassium and sodium will react very vigorously, producing hydrogen.

SUNAYANA: And if we hold a burning splint to the test tube, we'll hear a squeaky pop. [LOUD POP] The more reactive the metal, the more hydrogen has been made and so the louder the pop.

TULELA: Whereas those which are less reactive like the zinc and iron react very slowly with the acid, with a very quiet squeaky pop. [QUIET POP]

SUNAYANA: What about metals which are less reactive than hydrogen itself?

TULELA: Good point. So, metals such as copper won't react at all in the dilute hydrochloric acid and so no squeaky pop at all – and so they are placed below hydrogen in the list.

SUNAYANA: That's testing the metal with a dilute acid. We can also test to see how the metals react with water. And in the same way we'll find that those which are most reactive – like potassium and sodium – react vigorously.

TULELA: Again, hydrogen is released in this reaction which we can show with our squeaky pop test. [LOUD POP]

SUNAYANA: And less reactive metals such as zinc and iron react only very slowly, or not all in the case of copper.

TULELA: So, we've reacted a metal with water and dilute acids to see how reactive it is. But now we can also react a metal with a solution of a different metal compound to see how or indeed if it reacts at all.

SUNAYANA: For example, if we put an iron nail into a solution of copper sulfate, the iron which is more reactive will displace or kick out the copper from the sulfate and we'll be left with iron sulfate and copper metal. And this is an example of a displacement reaction.

TULELA: So it's a bit like if you have a dancing couple on the dance floor giving it some nice choreographed moves. They're the compound. But along comes a much more energetic dancer who displaces one of the couple and off they go together in a new compound leaving the poor displaced dancer on their own.

SUNAYANA: Story of my life. But if we try and react a less reactive metal into a solution of a more reactive compound then nothing will happen.

TULELA: That less reactive solo dancer cannot displace the more energetic one.

SUNAYANA: Just as with the experiments with water and dilute acid, we can use displacement reactions to work out where in the series a metal can be placed. And there are some examples of these on the Bitesize Chemistry web pages, so make sure you check them out.

TULELA: So if a metal reacts with a solution of another metal compound, then it is more reactive and so higher in the reactivity series. And if there is no reaction then it is less reactive and therefore lower in the reactivity series.

TULELA: Time for a quick-reaction quiz about quick reactions?

SUNAYANA: I see what you've done there, Tulela. OK go for it.

TULELA: OK podcast listening friends, three questions, five seconds each before we give you the answer. Or hit pause if you need a little more time to think about it. Here's question 1. In the reactivity series, what does it mean if one metal is placed above another?

SUNAYANA: The metal above is more reactive.

TULELA: Question 2. Potassium is higher in than reactivity series than calcium. What can we say about the how easily potassium and calcium form ions compared to each other?

SUNAYANA: Potassium is more reactive, so it loses its outer shell electrons more easily than calcium to form a cation.

TULELA: And question 3. In a reaction between zinc metal and magnesium chloride, nothing happens. What does that mean?

SUNAYANA: That zinc is less reactive than magnesium and so is below it in the reactivity series. Hope you got all of those right. Here's a quick summary of this episode – feel free to write these down if that helps you remember them.

TULELA: The reactivity of a metal is related to its tendency to form positive ions – cations.

SUNAYANA: We can put metals in order of their reactivity from their reactions with water and dilute acids. Remember the squeaky pop test for hydrogen. [LOUD POP]

TULELA: And a more reactive metal can displace a less reactive metal from a compound.

SUNAYANA: There's loads more about reactivity series and displacement reactions on the Bitesize webpages, or you can listen on Sounds to other chemistry topics in this series.

TULELA: Bye!

SUNAYANA: See ya!