BBC Bitesize – Physics

Episode 3 – Series and parallel circuits

JAMES: Hello and welcome to the BBC Bitesize Physics podcast.

ELLIE: The series designed to help you tackle your GCSE in physics and combined science.

JAMES: I'm James Stewart, I'm a climate science expert and TV presenter.

ELLIE: And I'm Ellie Hurer, a bioscience PhD researcher.

JAMES: Just a quick reminder, whilst you're here in the BBC Sounds app, there's also the Bitesize Study Support podcast, which is full of tips and tricks to help you stay focused during revision, and of course, get the best out of your actual exam day.

ELLIE: Right, let's get started.

So, I want you to imagine an electric circuit, the kind of one you probably made for the first time in primary school. It's wires that connect to different electrical components, like a light bulb, a switch, and a battery.

JAMES: Yeah, there are actually two types of circuits. We have series circuits and parallel circuits. Now in a series circuit, all the electrical components are connected by wires in one loop. So there's only one route for the current to flow. Now electrons pass through all of the components in the circuit in that one loop.

ELLIE: And on the other hand, a parallel circuit has electrical components on separate branches, so the electrons can take different routes around the circuit.

JAMES: And if you want to know exactly what that looks like, be sure to check out the BBC Bitesize website if you are someone that prefers to see rather than hear.

Series circuits and parallel circuits are both used a lot, but they have some really key differences, so let's start with series circuits.

ELLIE: Of course, so there are three key things that you need to know about series circuits. Firstly, in a series circuit, the same current flows through all of the different electrical components.

So the current at all parts of the circuit is the same. Secondly, in a series circuit, the total potential difference of the power supply is shared between all of the electrical components. And finally, the total resistance of all components in a series circuit is the sum of the resistance of each component.

JAMES: And that last point actually might come up in your exam as an equation, so we'll write that out for you. Grab a pen and paper, you can follow us through this one.

The equation to work out the total resistance of multiple components in a series circuit is: resistance total equals the sum of all the individual resistances added together.

ELLIE: For example, a circuit with three components would be R total equals R1 plus R2 plus R3. But one with two components would just be R1 plus R2.

JAMES: Yeah, so a key thing to know is that when you add a component in a series circuit, the total resistance increases because the total resistance is the sum of the resistance of each individual component.

ELLIE: Well, series circuits aren't that common in a regular house. But one great example is fairy lights, which I love.

JAMES: I'm glad we get to talk about fairy lights in the physics podcast. Um, a lot of fairy lights are designed as series circuits. There's one battery or plug, and then the lights are arranged into a circle, so the current flows in one direction.

ELLIE: You can tell that a set of fairy lights is a series circuit. If one bulb blows out, the circuit is broken, so the whole set stops working because the current flows in one loop. We know, it's so annoying, so annoying.

JAMES: But we will try and draw out a series circuit, so if you want to do that with us. Good time to grab your pen and paper.

So we want you to draw out a circuit in the shape of a square with one battery, one switch, and four light bulbs.

ELLIE: Could you say that it's like a mini set of fairy lights?

JAMES: Exactly what I would say it is.

ELLIE: Love it.

JAMES: So, from the information we've shared so far, how could you tell, in your mini fairy light circuit, that the one you're looking at is a series circuit? Have a little think for a moment.

ELLIE: So the key way to tell if a circuit is a series, is that it is one singular loop. There aren't any other branches or directions for the current to flow.

JAMES: Okay, let's move on to parallel circuits. Just like series circuits, there are three key things that you need to know about parallel circuits for your exam.

Number one, in a parallel circuit, the potential difference across each branch of the circuit is the same. In which case, the total potential difference in the battery is the same as the potential difference in each branch. But, in a parallel circuit, the current isn't the same. The total current throughout a parallel circuit is the sum of the current flowing through each of its separate branches.

And finally, in a parallel circuit, the total resistance of two resistors is less than the resistance of the smallest individual resistor.

ELLIE: That feels like a bit of a tongue twister, so let me repeat that.

JAMES: It was.

ELLIE: In a parallel circuit, the total resistance of two resistors is less than the resistance of the smallest individual resistor.

JAMES: And a key thing to know is that when you add other resistors to a parallel circuit, the total resistance decreases because it is less than the resistance of the smallest individual resistor.

ELLIE: And this is because more current is flowing for the same potential difference, which means resistance goes down.

JAMES: And just to note, whilst we're here, when we say resistor, that doesn't just refer to a fixed resistor, for example. All components in the circuit have a resistance. And in an exam question, they might actually ask you to calculate or explain the resistance of something like a lamp.

ELLIE: Right. We know that in a parallel circuit, the current can take different routes around the circuit. So, let's dive into what they look like in a circuit diagram. Okay, we're going to stick with the same example that we used last time, fairy lights, because they're my favourite.

JAMES: Why wouldn't you, yeah?

ELLIE: Exactly. But rather than the kind of fairy lights that completely turn off whenever one bulb breaks, we're going to draw the kind of fairy lights where the set keeps on working, even if one bulb breaks.

Ellie: So let's try drawing one. Grab your pen and paper. So, I want you to draw a long rectangle circuit with a battery and a light switch on one end. Then, draw four lines connecting the long sides of the rectangle and draw one light bulb on each row.

JAMES: Right, so how can you tell that the circuit you're looking at is a parallel circuit? Have a think for a moment.

The key way to tell if a circuit is a parallel circuit is that there are separate branches to the circuit. So if one lightbulb were to stop working, the current would still be able to flow around the circuit and light up the other lightbulbs.

ELLIE: This means that even if one bulb broke, your fairy lights would still light up.

JAMES: Phew.

ELLIE: Thank goodness.

JAMES: Okay, let's do a quick recap of the three key lessons we've learned today. Firstly, in a series circuit, the current is the same through each component. The potential difference is shared, and the total resistance for all components is the sum of the resistance of each component. Two, the equation to work out the total resistance of all components in a series circuit is: resistance total equals the sum of the resistance of each of the components.

And three, in a parallel circuit, the total current is the sum of the currents through each branch. The potential difference is the same across each branch of the circuit. And the total resistance of all resistors is less than the resistance of the smallest individual resistor.

ELLIE: Thank you, James. And sadly, guys, we're at the end of this episode about series and parallel circuits. However, in the next episode of Bitesize Physics, we're going to be talking all about the domestic uses of electricity and the three pin plug.

JAMES: Thank you for listening to Bitesize Physics.

BOTH: Bye!