BBC Bitesize – Physics

Episode 1 – Electrical charge and current

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.

This is episode one of our eight-part series all about electricity. And today we're going to be exploring electrical charge, current, and how to calculate them.

JAMES: Let's begin.

ELLIE: When we talk about how electricity flows, there are two key C's: charge and current.

JAMES: Yeah. Let's start with charge. There are two types of electric charge: positive and negative. Charged particles, such as electrons or ions, can transfer electrical energy. In metals, these charged particles are delocalised electrons that are free to move through the whole structure. Electrons are negatively charged.

ELLIE: And now let's move on to the second C, current. Electrical current is what we call the flow of electrically charged particles, such as electrons, as they move through an electrical conductor. It's how electrical energy flows through a circuit.

JAMES: Yeah, well, we measure current in amps using an ammeter. And when we do that, we measure the number of electrons passing a point in a circuit in just one second. The current is the same at any point in a circuit, so long as it's a single closed loop.

ELLIE: There are two types of electric current.

JAMES: Yeah, we have an alternating current and a direct current. That's AC and DC.

A direct current is when the electrons just flow in one direction around a circuit. So imagine a circuit that looks like a circle, for example. In a direct current, the electric current would either flow clockwise or anti clockwise. Not both.

ELLIE: An alternating current, on the other hand, is a current where the direction of the electron flow continually reverses.

JAMES: Yeah, the best way to remember the differences between the two is actually through their names. ‘Direct’ for doesn't change direction and ‘alternating’ for alternates direction.

ELLIE: So let's talk about how those work in a circuit. For an electrical charge to flow through a closed circuit, the circuit must include a source of potential difference.

Potential difference, also known as voltage, is the difference in energy the electrons have between two different points in a circuit. In a circuit, you've got to place a voltmeter in parallel with a component in order to measure the difference in energy from one side of the component to the other.

JAMES: Yeah, and by in parallel, what we mean is the voltmeter is on a separate branch of the circuit to the component in question.

ELLIE: We'll cover the difference between series and parallel circuits in more detail in episode 3.

JAMES: So for an electrical charge to flow through a circuit, there needs to be a voltage force. Let's use a lamp for an example. For that lamp to be turned on, you need to plug it into a wall socket, because the socket is the source of the voltage. Electricity can't flow through the plug up the wire and into the light bulb unless you plug it in.

ELLIE: Right, and when the lamp is plugged in, this then means the charge can flow, so you can then have a current. So, how do you measure the size of the electric current flowing through the wire to turn the light bulb on?

JAMES: There's luckily an equation for that Ellie, so grab your pen, grab your paper, we can write this one down together, if you want to do that.

The size of the electrical current is the amount of charge that passes a point per second, and the equation for calculating that is as follows: Charge equals current multiplied by time. I'll say that again. Charge equals current multiplied by time.

ELLIE: In this equation, we use the letter Q for charge, and it is measured in coulombs.

We then use the letter I for current, which is measured in amps, with the letter A. The unit for time is seconds, which is written as T. So this equation can also be expressed as Q equals I multiplied by T.

JAMES: Let's look at a practical example, and we'll give you the chance to, of course, work out the calculation, so grab your pen and paper.

So let's imagine you've made a simple circuit in your science class. It just has a battery, a light bulb, and a switch. Super simple. How would you calculate the charge that flows through the circuit if you knew the following? It had a current of 1.5 amps, and you want to measure the charge over the course of 60 seconds. I'll let you have a think for a moment and then we'll explain.

ELLIE: The equation is charge equals current multiplied by time. So you would take the current, 1.5 amps, then multiply it by the number of seconds, which is 60 seconds, to get the answer of 90

Coulombs. You can also rearrange that equation to find the current and in that case we would write the formula down as: current equals charge divided by time.

JAMES: Yeah, let's use that same circuit as an example. How would you work out the current, if the charge in the circuit was 90 coulombs over 60 seconds? I'll give you a few seconds to pause, then we can work it out together.

So to calculate the current flowing through the circuit, you would take the charge, 90 coulombs, and divide it by the number of seconds, that was 60, to get the answer, 1.5 amps. Simple as that.

Okay, let's summarise the key points we've learned from this episode. Really good one. Number one, for electrical charge to flow through a closed circuit, the circuit must include a source of potential difference. That's also known as voltage. Potential difference is the difference in energy the electrons have between two different points in a circuit.

Secondly, electrical current. We measure that in amps, and it's the amount of charge passing a point in the circuit per second. The equation that links these three is charge equals current multiplied by time. Well, you'll see that written down as Q equals I multiplied by T.

Third and finally, the current has the same value at any point in a single closed circuit. Thank you for listening to Bitesize Physics. If you found this helpful, please do go back, listen again and make some notes so you can come back any time you want and revise with us.

ELLIE: In the next episode of Bitesize Physics, we're going to focus on resistance and potential difference. So be sure to listen to the next episode and the rest of the series to make sure you're ready for your GCSE exam.

BOTH: Bye!