BBC Bitesize – Physics

Episode 3 - Specific heat capacity

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

ELLIE: Yeah, it's definitely worth checking out. So okay, let's get started. Today we're going to be talking about specific heat capacity.

James, do you like cooking?

JAMES: I do, I do indeed.

ELLIE: What's your favourite thing to make?

JAMES: Oh, I love a good roast, but I'm also like so impatient and it gets, takes so much time, but when you get it, it's so satisfying. How about you, Ellie?

ELLIE: I'll be honest. I just really love pasta.

JAMES: That's fine! I like it, good!

ELLIE: It's quick, easy and delicious. And it's the example we're going to use a lot today as we talk about heat.

So, when you heat food, or any material, the particles heat up and transfer energy from their thermal energy store to their kinetic energy store and they start moving faster. Which is why you sometimes see your food sizzling away when you've warmed it up.

JAMES: Yeah, looks good, doesn't it? And as you'll note, if you've ever looked at all the settings on a microwave, different materials require different amounts of energy to change temperature.

The amount of energy they need depends on the mass of the material, how much you want the temperature to change, and the substance.

ELLIE: And that last one is what we're going to focus on, the substance of the material, because that's what determines a material's specific heat capacity.

JAMES: Specific heat capacity is the amount of energy required to raise the temperature of one kilogram of a substance by one degree Celsius. So in your case, Ellie, that will be the amount of energy you need to raise a temperature of one kilogram of water by one degree Celsius.

ELLIE: So, let's talk about how to calculate the change in thermal energy that occurs when we heat something up. Grab a pen and piece of paper because it's time for a formula.

JAMES: We need, like, a klaxon, don't we? Or a bleep or a buzzer of some kind there.

Okay, so change in thermal energy equals mass multiplied by specific heat capacity, multiplied by temperature change.

I'll say that again with the units that we measure those in. So change in thermal energy is measured in joules, and to calculate it we take the mass of a material, measured in kilograms, multiply it by the specific heat capacity, measured in joules per kilogram degrees Celsius, and then we multiply it by the temperature change measured in degrees Celsius.

ELLIE: So just take a note that you might have to change the mass of a material into kilograms. So you need to remember that 1,000 grams is equal to 1 kilogram.

JAMES: That's handy to know. My partner's a baker and like, that's every day in my house, the conversation, “How many kilograms is that?” like, every day.

ELLIE: So yeah, you can use this in everyday life.

JAMES: Yeah, literally. It applies to all circumstances.

ELLIE: So, let's talk about how to apply that to a practical example. Imagine it's a Friday night, you're chilling, and you want to boil some water to make some pasta.

JAMES: So you might take 0.5 kilograms of water and heat it up from 20 degrees Celsius to 100 degrees Celsius. And water has a specific heat capacity of 4,180 joules per kilogram per degree Celsius. So how would you work that out? I'll give you a few seconds to take the equation, write it down and calculate it for yourself.

ELLIE: Okay, did you finish your calculations? Let me explain. So, you would multiply 0.5 kilograms by 4,180 joules per kilogram per degree Celsius. Then, you'd multiply that by the 80 degrees Celsius temperature change to get the answer...

JAMES: 167,200 joules.

ELLIE: That's correct.

JAMES: Wahoo!

ELLIE: Woo!

JAMES: So imagine you wanted to make some iced coffee. I love iced coffee.

ELLIE: That's my favourite.

JAMES: Yes, always my order. Even if you made your hot coffee and gave it a few minutes to cool down, it still wouldn't be cool enough as a refreshing cool drink on a summer's day. So, you'd pop it in the fridge, wouldn't you?

ELLIE: Yeah, but how would you calculate the thermal energy change between you putting it in the fridge and then taking it out to drink the next day? Well, it's time to grab your pen and paper again because it's time for another calculation.

JAMES: The equation to calculate change in thermal energy is mass multiplied by specific heat capacity, multiplied by temperature change.

ELLIE: So, if the mass of the coffee was, say, 0.2 kilograms, the specific heat capacity of the coffee was 4,180 joules per kilogram. And if it was cooled down from 80 degrees Celsius to 3 degrees Celsius, how would you calculate the thermal energy change?

JAMES: If you missed a measurement in that or you missed the equation, be sure just to rewind 30 seconds and listen back, no problem. We'll give you a few moments to pause, write that down and calculate it.

Okay, so to calculate the heat change, you would simply multiply 0.2 kilograms by 4,180 joules per kilogram per degree Celsius. Then you multiply that by minus 77 degrees Celsius temperature change to get the answer...

ELLIE: Minus 64,372 joules

JAMES: Yes, that's right. And look, we know there's a lot of numbers and measurements in what you've just heard, so be sure to check out the BBC Bitesize energy and heating pages to read the formula and apply it to your own range of examples.

ELLIE: So, it's that time that we need to go through key points that we've learned today. So firstly, different materials require different amounts of energy to change temperature. Also, the specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.

And finally, the equation to calculate change in thermal energy is: change in thermal energy is equal to mass multiplied by the specific heat capacity, multiplied by temperature change.

JAMES: Alright, so those are some of the key facts you need to know about specific heat capacity and in the next episode, we're going to be talking about how to apply what you've learnt to the practical every day. So, get ready to get stuck into that.

ELLIE: Thank you guys for listening again to BBC Bitesize Physics. If you found this helpful, go back and listen again and make some notes so you can come back to this as you revise.

BOTH: Bye!