# BBC Bitesize – Physics

# Episode 7 - Efficiency

**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. And let's get started.

**JAMES:** So in the last episode, we touched on the topic of efficiency. If you haven't listened to that episode 6, last episode, be sure to head back there because it has some really helpful information you'll need to understand just what we're talking about today.

Efficiency is how well an object achieves maximum productivity with minimum waste. So, for example, a lightbulb that is supposed to light up a room, that instead makes it really hot, isn't very efficient because it's wasting heat energy. This is why we have energy-efficient light bulbs.

To calculate how efficient an energy transfer is, you need to understand a key equation.
So, grab your pen and paper if it's handy.

Efficiency equals useful output energy transfer, divided by total input energy transfer.

**ELLIE:** So let me give you that equation again this time with the units of measurement that we need to use. So, efficiency equals useful output energy transfer, which is measured in joules, divided by total input energy transfer, which is also measured in joules.

**JAMES:** Handy. And it's important to know that efficiency doesn't have a unit. Instead, it's given as a decimal or as a percentage. So, let's use a lightbulb as an example. Let's imagine you just bought a new lamp for your bedside table and you had to pop out to the supermarket and buy yourself a lightbulb.

**ELLIE:** So, if the lightbulb is supplied with 200 joules of energy and only 28 joules of that energy is used to actually light it up, how would you work out how efficient the lightbulb is?

**JAMES:** Well, you would divide 28 joules, that's the useful output energy transfer, by 200 joules, the title input energy transfer, to get the answer 0.14. So the bulbs efficiency is just 0.14. To calculate the percentage of efficiency, you multiply efficiency by 100, so 0.14 multiplied by 100 - therefore, the energy percentage efficiency is 14%.

**ELLIE:** Most of the energy isn't used to light up a room. It's dissipated, which means it's wasted, by being transferred into other energy stores like the thermal energy store of the surrounding air particles. This means that the light bulb is not very efficient.

**JAMES:** Yeah, so basically you need to get a better bulb for your lamp, is what we're saying.

**ELLIE:** Buy a better bulb.

You can also measure efficiency with a similar equation. So, it's time to grab your pen and paper again. Right, so, efficiency equals useful power output, which is measured in watts, divided by total power input, which is also measured in watts.

**JAMES:** Let's try another example. So imagine it's your best mate's birthday and you decided to make them a cake. You're a very good friend. So you reach into your cupboard, and you grab your mixer.

That mixer had an input of 400 watts of power, but it only used 110 watts of that power to actually mix the cake batter. So how efficient is that mixer?

**ELLIE:** I'll give you a second to try and calculate that by yourself. And just as a reminder, the equation is: efficiency equals useful power output, which is measured in watts, divided by total power input, which is also measured in watts.

**JAMES:** So, to calculate the mixer's efficiency, you would divide 110 by 400 to get the answer of 0.275. If you were to multiply that by 100, you would get the percentage efficiency of 27.5%, which means, again, that mixer isn't really that efficient.

**ELLIE:** So maybe you should just use a wooden spoon to make the cake batter instead. That way, you'll save electrical energy.

**JAMES:** That’s what I get told to do at home, yeah, I will do.

**ELLIE:** Also, it's useful to know that efficiency can never have a value of more than one if the answer is being given as a decimal, or more than a hundred if the answer is being given as a percentage. So, if you ever calculate and get more than that, you'll know that you've gotten the wrong answer and you need to go back and try again, basically.

**JAMES:** It's a good tip though, that one.

So the key question, I guess, Ellie, is how can you increase the efficiency of an energy transfer then?

**ELLIE:** Yeah, there are so many ways to do that, but if we're talking about houses, the most efficient is probably insulation. One great way to tell which house on the street has the best insulation is to look at the roof when it snows.

**JAMES:** Yeah, if the roof on one house has lots of snow on it, that probably means that it's better insulated and that the house has been built with materials or been insulated in a way that keeps the heat in because the snow melts more slowly.

**ELLIE:** Whereas, the house with less snow on its roof is probably less insulated, which means the heat from inside the house is warming up the snow.

People can insulate their homes using things like double-glazed windows, cavity walls, carpets and curtains and loft insulation.

**JAMES:** Yeah, and this doesn't just apply to homes as well. Light bulbs made of thicker glass waste less heat energy, and even serving dishes made with thicker, less conductive materials keeps food warmer for longer.

**ELLIE:** And when it comes to designing products or mechanical equipment, lubricating the different parts will reduce friction. This means there will be less wasted thermal energy and the item will be more efficient.

**JAMES:** So the next time you go shopping for an appliance or an electric item, have a look at its energy efficiency. You'll see it in a whole new way. It's usually written out on a label covered with red, yellow, orange and green arrows.

**ELLIE:** Before we go, I have a question for you. What household appliance do you think is the most efficient? I'll give you a minute to think.

**JAMES:** The answer is...

**ELLIE:** Duh, duh, duh, duh, duh...

**JAMES:** A heater!

**ELLIE:** Woo!

**JAMES:** Woo! Very handy. Because its job is actually to transfer energy to the thermal energy stores of itself and the air around it which is really smart. There's very little wastage, if any at all, really.

**ELLIE:** So, I think the key takeaway here is to get yourself a heater.

**JAMES:** Yes, I think so. Job done.

**ELLIE:** Job done.

Before we finish this episode, let's recap the three key takeaways. The first equation to calculate efficiency is: efficiency equals useful output energy transfer, divided by total input energy transfer.

The second equation to calculate efficiency is: efficiency equals useful power output, divided by total power input.

And finally, two methods of increasing efficiency are: insulation and lubrication.

**JAMES:** So that's a great introduction to efficiency and how to calculate it. It might even help you pick out the best light bulbs and the devices you need when you go shopping next.

**ELLIE:** Thank you for listening 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 any time when you revise.

**BOTH:** Bye!