BBC Bitesize – Physics

Episode 5 – Displacement, distance and speed

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: Today we're going to be talking about displacement, distance and speed. Shall we?

ELLIE: Let's begin. So, James, do you remember how we talked about scalar and vector quantities in episode one?

JAMES: Oh yeah, I do. Scalar quantities just have a magnitude, whereas vector quantities have a magnitude and a direction.

ELLIE: And we can apply that to today's topics too, as we talk about distance, displacement, speed and velocity.

JAMES: Yeah, let's start off with some definitions. We love a definition. So distance is how far an object moves, for example, getting into a car and driving 10 miles.

Distance is a scalar quantity because it only includes magnitude. In this case, that's miles.

ELLIE: Right, and a similar but different term is displacement.

Displacement is a vector quantity. Displacement includes both the distance an object moves, say 10 miles again, but also the direction, for example, north. And when we measure displacement, we measure it from the start point to the finish point in the direction of a straight line.

JAMES: So if we were describing the displacement of a car, we'd say something like, I drove the car ten miles north. Which, you're right, makes it a vector quantity because of measuring both distance and direction.

ELLIE: Okay, yep, that makes sense. Distance is just distance, and displacement is both distance and direction.

JAMES: But a moving object can have a different value for its distance and its displacement.

For example, a car going along a winding road might travel a distance of half a mile. But have a displacement of a quarter of a mile to the east. Now that could be because the displacement is measured as a straight line from the start to the end point.

ELLIE: Another interesting example is someone running around a 400 metre track. They would have a distance of 400 metres, but a displacement of zero.

So, for the next topic, we need to head to the racing track, because we're going to explore… speed.

JAMES: Can you hear how quickly those cars are going in here? It's like being trackside at the Formula 1.

ELLIE: It is! Did you know that the fastest recorded Formula One car drove at just over 397 kilometres per hour.

JAMES: So you're probably already familiar with speed. It's how fast or slowly an object moves. Speed is a scalar quantity because we only measure magnitude. And if you want a quick way to remember that, speed and scalar, well they both start with an ‘s’.

ELLIE: But how do we calculate speed? Well, grab your pen and paper, because you're going to want to write this down. Right, let's start with the equation. Distance equals speed multiplied by time taken. But you can rearrange that equation to calculate speed.

So speed equals distance divided by time taken. Distance is measured in metres, time is measured in seconds, and speed is measured in metres per second.

JAMES: So let's look at that as a practical example. Again, grab your pen and paper if you want to write this out, and follow along with the calculation.

So let's imagine a race car drives 100 metres in the space of 10 seconds. Speed equals distance divided by time taken. So the answer to the calculation would be that the race car drives at a speed of 10 metres per second.

ELLIE: So let's flip that equation around to measure distance, too. If you're measuring the distance travelled by a moving object in a specific time, distance travelled equals speed multiplied by time.

JAMES: Okay, now it's your turn to try and work it out. I'm gonna give you an example. So if a car travelled at a speed of 15 metres per second, and it travelled for 20 seconds, how would you calculate its distance? We'll give you a few moments to work that one out.

Using that equation, we could calculate its distance by writing out that 15 metres per second multiplied by 20 seconds equals a distance of 300 metres.

ELLIE: Well done, James.

JAMES: Thank you.

ELLIE: So, let's maybe rewind that equation and make sure you have it down. If you're measuring the distance travelled by a moving object in a specific time, distance travelled equals speed multiplied by time.

JAMES: By the way, good time to mention the standard units of measurement, you know how important that is in physics, in these equations are metres, seconds, and metres per second. However, some questions might use different units, so whatever's being used in the question, best to use that in the answer.

ELLIE: Let's say, for example, if the question asked you to calculate the speed of a race car that drove 100 kilometres over the course of 10 minutes, you would identify the time is in minutes, and the distance is in kilometres, therefore the speed would be measured in kilometres per minute instead.

But in the exam, if you're asked to give your answer in a particular unit, then you might have to convert that answer, for example from minutes to seconds.

JAMES: Okay, now we've learned about speed, how about velocity?

ELLIE: Well, well, well. Velocity is the speed of an object in a given direction. For example, a race car driving 80 miles per hour south.

Because we're measuring both speed and direction, velocity is a vector quantity. To memorise that, just remember that vector and velocity both start with a ‘V’.

JAMES: Although speed and velocity are different things, they are calculated using the same equation. So instead of saying that speed equals distance divided by time, you would say that velocity equals displacement divided by time.

ELLIE: But the key difference to know when you're doing that calculation is that when you calculate velocity, you must also include a direction in your answer. So you can't just say that a race car is driving at a hundred and fifty miles per hour. You would say that race car is driving at one hundred and fifty miles per hour east.

JAMES: Before we go, let me give you a quick recap of what we've learned today then. So firstly, speed and distance are scalar quantities. Because we just measure their magnitude.

Secondly, displacement and velocity are vector quantities, because we measure both magnitude and direction. Remember, v and v.

And finally, the equation to calculate distance travelled is distance travelled equals speed multiplied by time.

ELLIE: Fabulous.

So that's all you need to know for now about displacement, distance and speed. But be sure to listen to the next episode where we're going back to the racetrack to learn the essentials of velocity and acceleration.

JAMES: Oh yes, back to the racetrack, finally. Thank you for listening to Bitesize Physics. If you found this helpful, please do go back and listen again, make some notes and come back here as many times as you want to help you revise.

ELLIE: There's also lots more resources available on the BBC Bitesize website, so be sure to check that out.

BOTH: Bye!