Sample of the IGCSE Science (Double Award) Course, from Physics Section 1

Topic 1

Distance and speed

Introduction

This topic deals with speed and distance. It also introduces you to some important skills and techniques in science, including using your calculator, deciding on how to present an answer, and drawing a graph. You will start by reviewing some essential maths skills for Physics.

You will probably need 2 hours to complete this topic.

Objectives

When you have completed this topic you should be able to:

- know and apply the relationship between average speed, distance moved and time taken
- plot and interpret distance–time graphs.

Study hint

For this topic you will need graph paper and a calculator (don't use your phone for this). You can get free graph paper online. Try using a search engine with the term 'printable graph paper'.

Essential maths skills

Converting between units

To convert between units:

100 cm = 1 m

1000 m = 1 km

60 s = 1 min

60 min = 1 h

Note that units are never given a plural form, so kms, hrs, hs, mins, etc. are not used. In everyday life you will often see 'secs' for seconds, but this is not correct – please use s.

Standard form

Scientists frequently handle both large and small numbers. For example, the speed of light is 300 000 000 m/s and the average diameter of a human hair is 0.0001 m.

To make it easier to handle these numbers we can use **standard form**. This consists of a number between 1 and 9, with any decimal fraction (this is known as the **mantissa**), followed by a power of 10, which is called the **exponent**.

The following is 6789 expressed as standard form: 6.789×10^3

10^3 stands for $10 \times 10 \times 10$. The number given as a superscript (3 in this case) is the number of times you multiply by 10.

The pattern of exponents is:

$10^3 = 10 \times 10 \times 10$ (= 1000)

$10^2 = 10 \times 10$ (= 100)

$10^1 = 10$

$10^0 = 1$

$10^{-1} = 1 \div 10^1 = 0.1$

$10^{-2} = 1 \div 10^2 = 0.01$

$10^{-3} = 1 \div 10^3 = 0.001$

And so on.

Don't worry if you are not familiar with this – practice will help.

Entering these numbers into your calculator can be tricky. You would enter 6.789×10^3 as follows:

6	.	7	8	9	EXP	3	=

Casio scientific calculators now have a $\times 10^x$ key, rather than EXP.

Note in particular that entering 10EXP3 (or 10 $\times 10^x$ 3) returns the number 10000 and not 1000. To obtain 1000 you enter 1EXP3 (or 1 $\times 10^x$ 3).

For entering a small number such as 6.789×10^{-3}, this is required:

6	.	7	8	9	EXP	-	3	=

Or 6.789 ×10^{x} (-) 3.

Make sure that you become familiar with your own calculator as soon as possible.

A word of caution

Many students use their phone as a calculator. Unfortunately you are not permitted to have your phone in an exam situation, so please don't start to use it for your GCSE studies, except in emergencies. Get to know your calculator!

Precision

Calculators will often give you answers with lots of figures in the window. These are not usually justified. For example, if you measured the width of your dinner table to be 1382 mm to the nearest millimetre and its length to be 2460 mm to the nearest millimetre, then we could work out the area to be 1382 × 2460 mm^2. A calculator gives this as 3399720.

Since you only measured the table to four-figure accuracy, you should round off your final answer to that level. The fifth figure in this number is 7, so it causes the one to the left to be rounded up, and the result is: 3400000.

When rounding to four figures you look at the next (fifth) figure. If it is 5 or more the fourth figure is rounded up. If it is 4 or less it stays the same.

Don't worry that 3400000 appears to only have two significant figures. When using standard form the precise number of significant figures can be indicated thus:

3.400 × 10^6

The two zeros after the decimal point indicate that these figures were significant.

Activity 1

(Allow 10 minutes)

1 Round the following numbers to the stated number of figures:

(a) 3.142 (to 2 significant figures)

(b) 6.789 (to 3 significant figures)

(c) 6.789 (to 1 significant figure)

(d) 6.719 (to 2 significant figures).

2 The national speed limit on dual carriageways is 70 miles per hour, which converts to 112.7 km/h. Convert this to m/s. Express this in standard form.

3 Convert 100 m/s to (a) cm/s and (b) km/h. Express both of your answers in standard form to two significant figures.

1 (a) 3.1; (b) 6.79; (c) 7; (d) 6.7.

2 112.7 km is 112.7 × 1000 m. There are 3600 s in 1 h, so the speed becomes: 112.7 × 1000 /3600 = 31.3 m/s. This is 3.13 × 101 m/s.

3 (a) 100 m/s is 100 × 100 cm/s, which is 1.0 × 104 cm/s.

(b) 100 m is 100 ÷ 1000 km. There are 3600 s in 1 h, so this converts to (100/1000) × 3600 = 360 km/h. This is 3.60×10^2 km/h. Finally, we asked you to round to two significant figures, which is 3.6×10^2 km/h.

If some of this maths is new to you, we suggest you access the Maths Help document for this section of the course, which will give you some more practice. You can return to it at any point during the course if you need a refresher.

Speed

Speed and velocity

You can probably think of two words that describe how fast things move – speed and velocity. In everyday life we tend to use these terms interchangeably, but in physics these have distinct meanings.

Speed is the distance travelled divided by the time taken and it is measure in units of distance per unit time. This could be:

- metres per second (m/s)
- centimetres per second (cm/s)
- kilometres per hour (km/h).

Velocity not only describes the speed (distance divided by time), but also defines the direction of motion. An object travelling at 1 m/s going north has a different velocity from an object travelling 1 m/s going east (even though they have the same speed).