Combined Science GCSE

Course plan and sample

The Course plan below shows the structure of the course and gives an outline of the contents. A sample from the course follows and is highlighted in the plan.

Getting Started

Introduction

Combined Science GCSE Course guide

Unit 1: Physics

P1: Motion

P2: Matter and forces

P3: Energy, work and power

P4: Energy resources

P5: The kinetic model of matter

Assignment 1

Unit 2: Chemistry

C1: Atoms and molecules, elements and compounds

C2: Chemical and physical change

C3: Atomic structure and the periodic table

C4: Chemical bonds

C5: Formulas and equations

Assignment 2

Unit 3: Biology

B1: Living things

© 2017 The Open School Trust – National Extension College

B2: Movement in and out of cells and the role of enzymes

B3: Animal nutrients

B4: Plant nutrition

B5: Animal nutrition

Assignment 3

Unit 4: Physics

P6: Thermal energy

P7: Waves

P8: Reflection of light

P9: Refraction and total internal reflection

P10: Electromagnetic spectrum

Assignment 4

Unit 5: Chemistry

C6: Electricity and chemistry

C7: Periodic trends

C8: Acids and bases, preparation of salts

C9: Reactivity series

C10: Identification of ions and gases

Assignment 5

Unit 6: Biology

B6: Transport in plants

B7: Transport in humans

B8: The human circulatory system

B9: Respiration and gas exchange

B10: Coordination and response

Assignment 6

Unit 7: Physics

P11: Sound

P12: Electric charge

© 2017 The Open School Trust – National Extension College

P13: Electric current

P14: Practical electricity

P15: Series and parallel circuits

Assignment 7

Unit 8: Chemistry

C11: Metals

C12: Reactions: energy changes and rates

C13: Air and water

C14: Fuels

C15: Alkanes and alkenes

Assignment 8

Unit 9: Biology

B11: Reproduction in plants

B12: Sexual reproduction in humans

B13: The development of the human baby

B14: Energy flow in ecosystems

B15: The human influences on the ecosystem

Assignment 9

© 2017 The Open School Trust – National Extension College

Motion

TOPIC P1

Introduction

In this topic we will look at describing how things move. How fast? How far? Are they getting faster?

You will learn about

- speed and acceleration
- drawing and interpreting distance/time and speed/time graphs
- calculating distance travelled and acceleration
- calculating acceleration and distance travelled from speed/time graphs.

Before beginning this topic make sure that you have the following available:

- graph paper
- a calculator.

Useful tip

You can get graph paper free of charge from www.mathsphere.co.uk/resources/MathSphereFreeGraphPaper.htm

For most purposes you will find the '2 mm graph paper' link to be the most useful. If you want closer spaced lines try the 'graph paper' link. It's probably a good idea to print off about 10 pages, as you will need graph paper quite frequently in this course.

© The Open School Trust

Key terms

You will meet the following terms in this topic:

acceleration

gradient

mean speed

speed

velocity

Speed

You can probably think of two words that describe how fast things move – **speed** and **velocity**. Physicists use both of these words, but each one has a slightly different meaning.

Speed is the distance travelled divided by the time taken and is measured 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 distance divided by time, but also defines the *direction* of the 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).

Note that at IGCSE level you only study speed, but it is important to know the subtle difference between speed and velocity so that you use the correct word in your studies.

We calculate speed as:

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

We might use symbols u or v for the speed, d for the distance and t for the time, so this would become:

$$v = \frac{d}{t}$$

or

$$u = \frac{d}{t}$$

© The Open School Trust

Activity 1

Calculate the speed of something that travels:

1 7 m in 2 seconds, expressing your answer in m/s

2 1 m in 5 seconds, expressing your answer in cm/s (remember that there are 100 cm in 1 m)

3 10 km in 20 minutes, expressing your answer in km/h.

You will find feedback to activities at the end of the topic.

Drawing a distance/time graph

You can use a computer to draw graphs using Microsoft Excel or other similar packages, but it's important that you practice drawing by hand as well, because you won't have your computer with you in the exam.

Imagine you're watching a runner (Runner A) and photograph her position every two seconds. Your sequence of pictures might look like this:

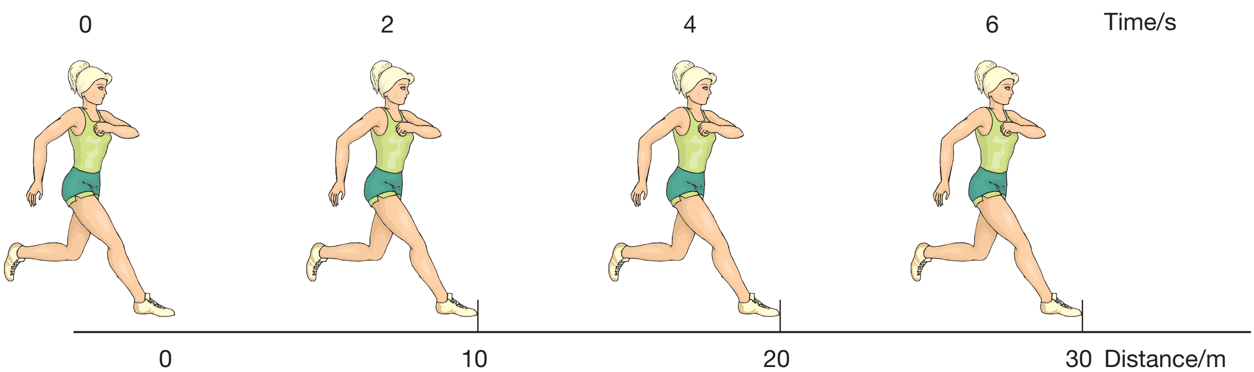

Figure 1.1 Runner A

© The Open School Trust

Activity 2

Using Figure 1.1 measure the distance travelled at 0, 2, 4 and 6 seconds and fill in the table.

Time/s	Distance/m
0	
2	
4	
6	

You will find feedback to activities at the end of the topic.

You can now draw a graph using the measurements from Activity 2. First, draw the axes for your graph.

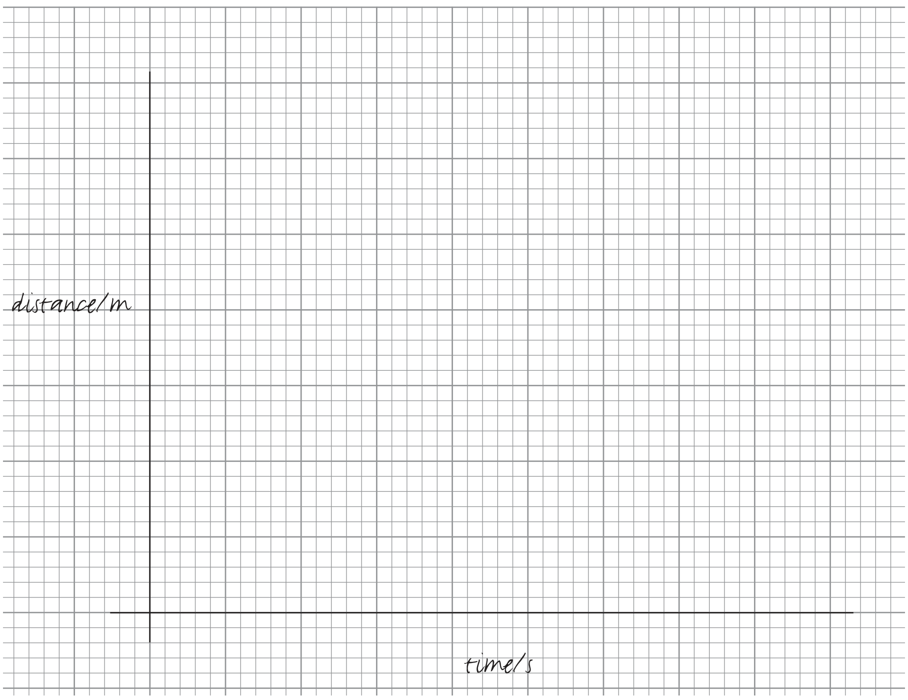

Figure 1.2 Starting the graph

Note that there is a convention for writing labels for axes and headings for tables. You state the quantity then put a slash (/), followed by the unit(s) of measurement. So the distance axis will be labelled 'distance/m'.

© The Open School Trust

Then you need to choose a scale to display the figures. If the scale is too small the graph will be difficult to use and any calculations will contain errors. If the scale is too big you won't be able to fit all the points on the graph. You therefore have to pick something in between.

Useful tip

Avoid using one square on the graph paper to represent 3, 6, 9 or other multiples of 3 because these are difficult to plot. Multiples of 2, 5, 10 are good choices. See Figure 1.3 for some common mistakes made when choosing a scale.

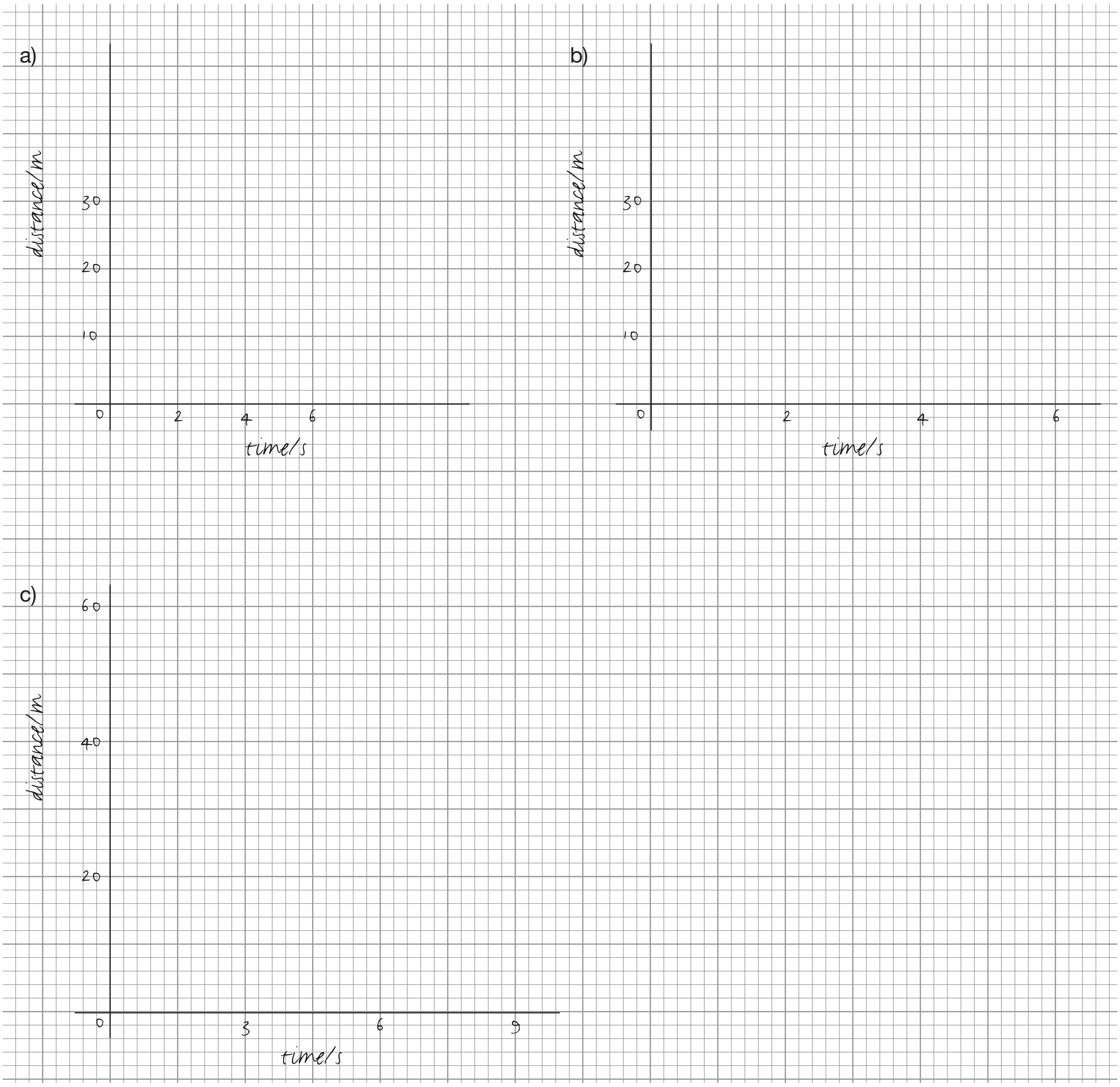

Figure 1.3 Mistakes in graph scales: a) too small, b) distorted in one direction, c) difficult to plot

© The Open School Trust

Now start plotting the points. This is where the point for t = 2s goes (see Figure 1.4).

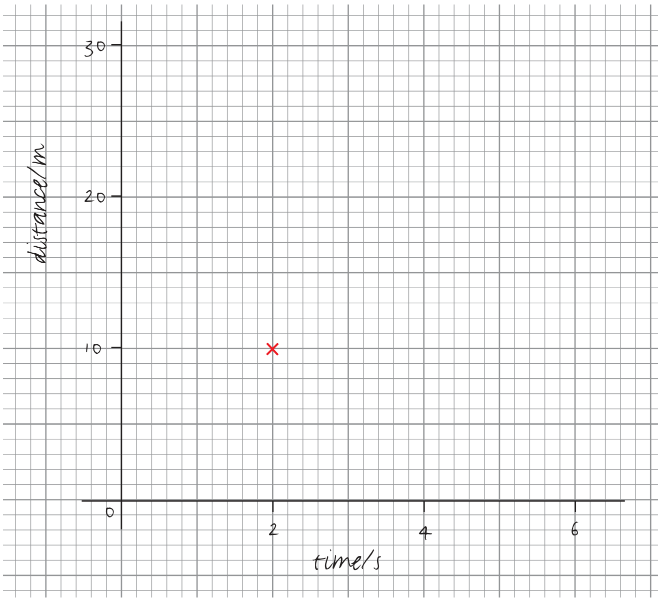

Figure 1.4 Starting the plot

When you have plotted your figures, lay a ruler against them and you should notice that they are all in a straight line. This is the kind of distance/time graph you get when the speed is constant, i.e. the object travels equal distances in equal times.

The speed is the **gradient** (slope) of the line. We measure this by drawing a triangle on the line, measuring its height and width, and calculating the ratio of these (see Figure 1.5).

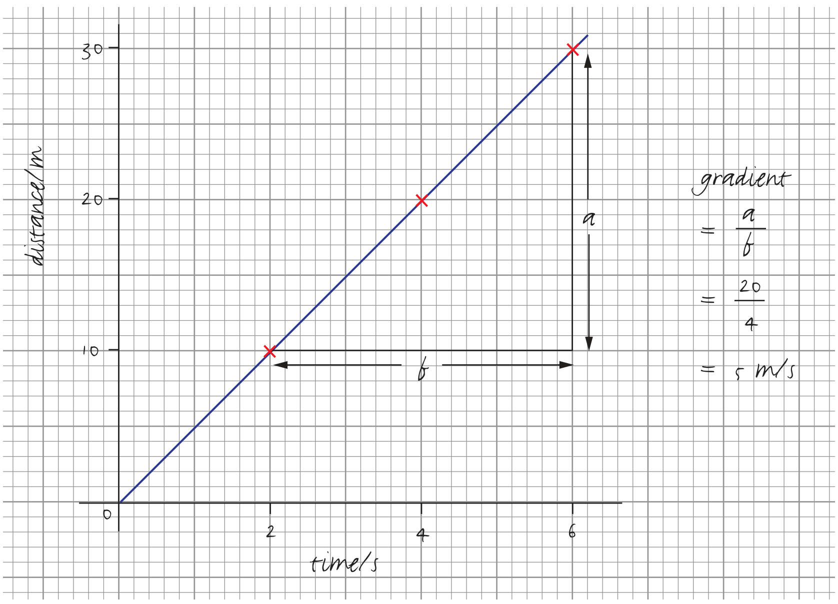

Figure 1.5 Drawing and measuring a gradient

© The Open School Trust

The speed of the runner is 5 m/s. It was quite easy to see this from the numbers in the table, but not all graphs are so simple.

Activity 3

This is a more challenging example. Figure 1.6 shows a distance/time graph where there are a number of sections, each with a different slope. See if you can answer the following questions.

1 In which part of the graph is the body moving with the greatest speed?

2 Can you measure the gradient of the graph in this section and estimate the speed?

3 If you measure the total distance travelled from the graph, and the total time, can you calculate the average or **mean speed**?

$$\text{Mean speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

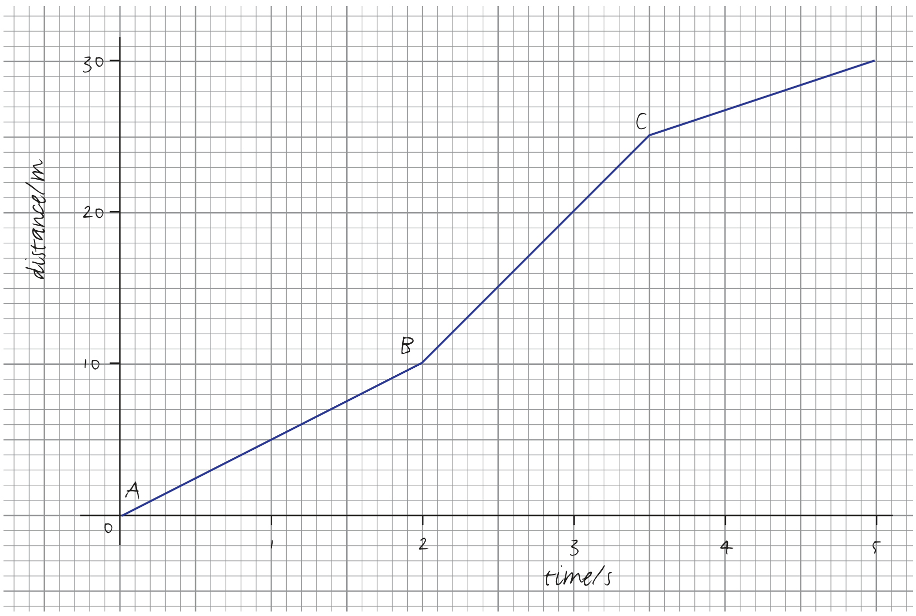

Figure 1.6 Distance/time graph with different slopes

You will find feedback to activities at the end of the topic.

Speed/time graphs

We can also plot the speed against the time and this kind of graph gives us further information. For Runner A in Figure 1.1 the speed/time graph would look like this:

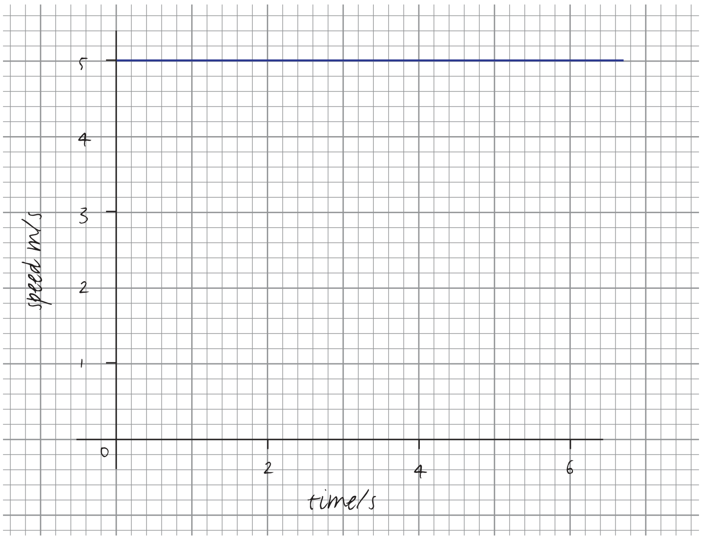

Figure 1.7 Speed/time graph for Runner A

Notice that the distance/time graph was a straight diagonal line, which indicated constant speed. This translates into a straight horizontal line on the speed/time graph.

Activity 4

See if you can sketch a graph to represent a body that is at rest, i.e. it is moving with zero speed.

A sketch graph has axes that are labelled to show the quantities and has a line showing the overall trend, but it has no values marked on it.

You will find feedback to activities at the end of the topic.

© The Open School Trust

Acceleration

Acceleration is a word used in everyday life and describes speed that is changing. It is defined as the rate of change of speed and is measured in units of m/s^2. The unit has a superscript ^{2} to indicate that it is 'metres per second' per second.

It is calculated as:

$$\text{Acceleration} = \frac{\text{change in speed}}{\text{time}}$$

In symbols we usually use v for the final speed and u for the initial speed. We use a for acceleration, so this becomes:

$$a = \frac{(v - u)}{t}$$

Suppose we now have two runners who are being monitored by a radar speed gun which is giving speed in m/s at two-second intervals (see Figure 1.8).

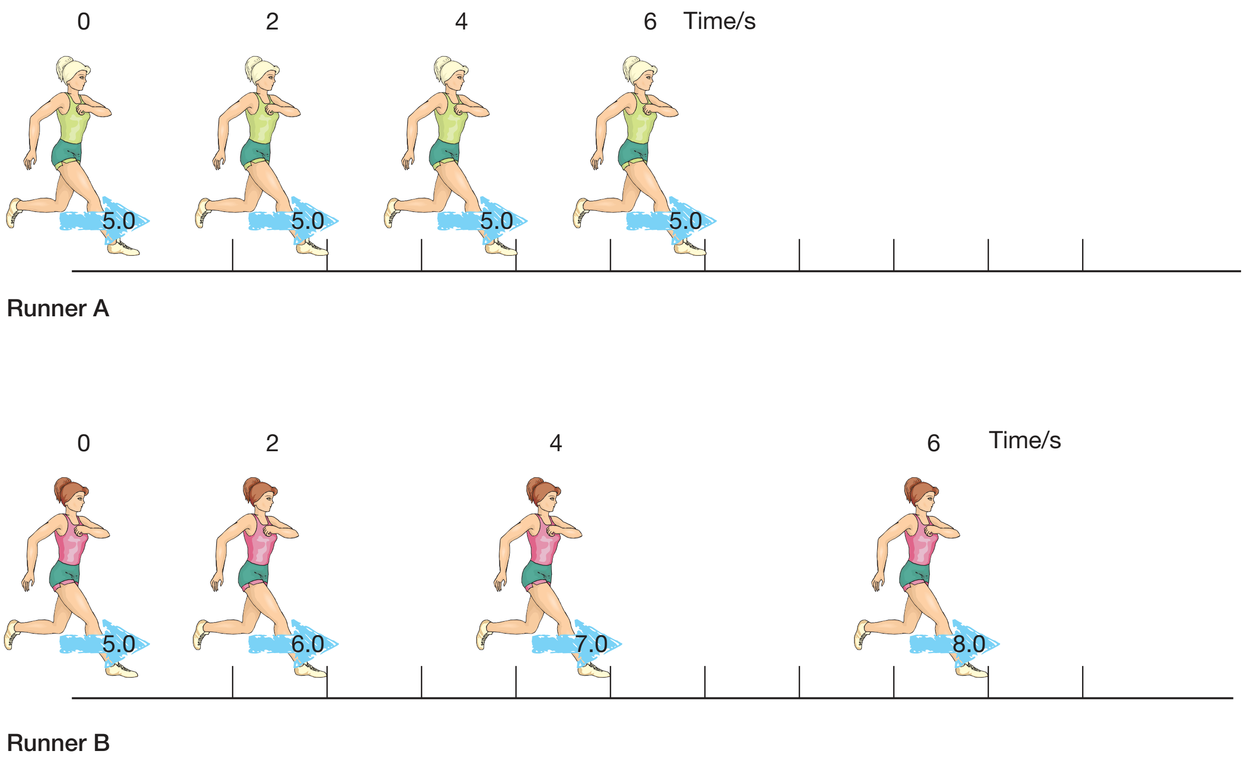

Figure 1.8 Runner A and Runner B

© The Open School Trust

I compiled the following table.

Table 1.1 Speeds of Runner A and Runner B

Time/s	Speed of Runner A/ m/s	Speed of Runner B/ m/s
0	5	5
2	5	6
4	5	7
6	5	8

The speed/time graph could look like this:

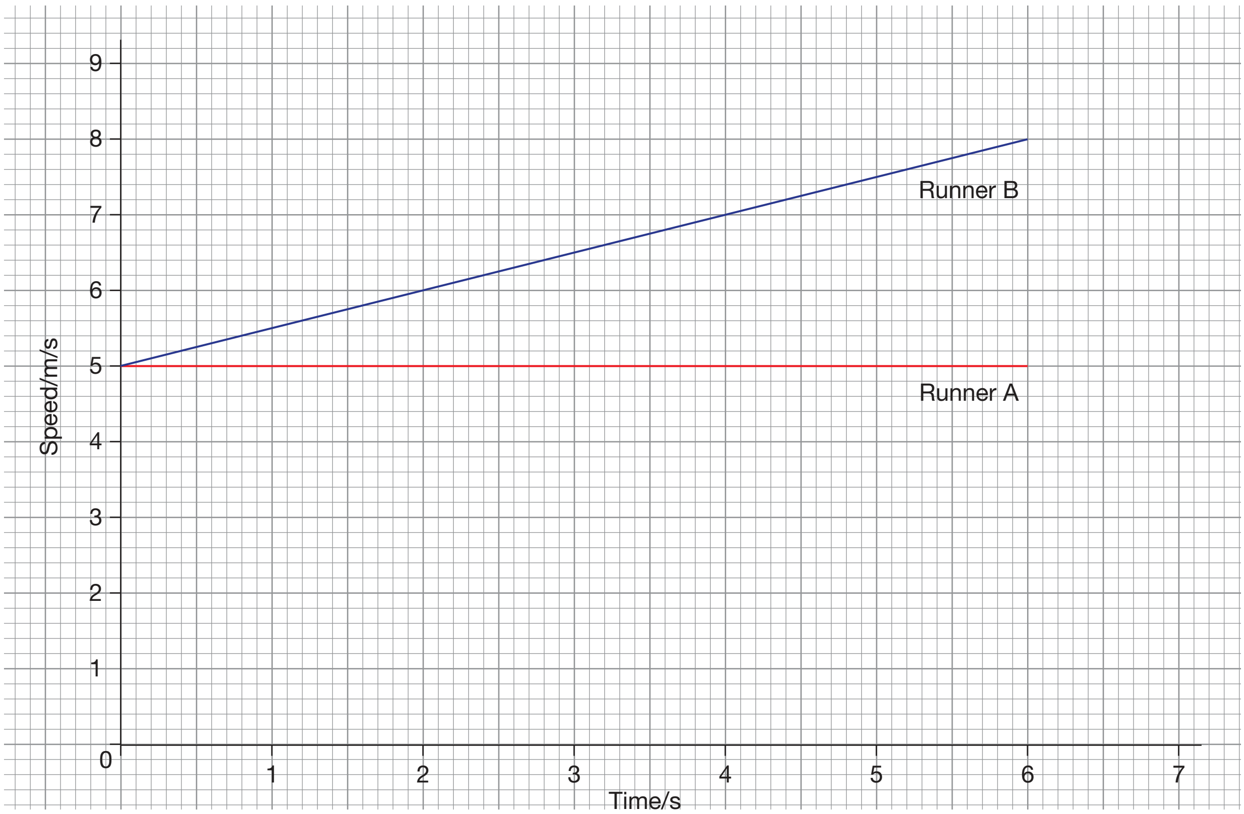

Figure 1.9 Speed/time graph for Runner A and Runner B

The figures show that Runner B accelerated from 5 m/s to 8 m/s within the space of 6 seconds. This gives us the following calculation.

Acceleration = $\frac{(8-5)}{6} = 0.5\ \text{m/s}^2$

You'll see that you get approximately the same answer by measuring the slope of the speed/time graph. You'll also see that by calculation and by measuring the slope of the graph the acceleration of Runner A is zero.

© The Open School Trust

Constant and non-constant acceleration

When something is moving with constant acceleration the speed/time graph is a straight line. When the acceleration is varying the line is not straight. This is illustrated in Figure 1.10.

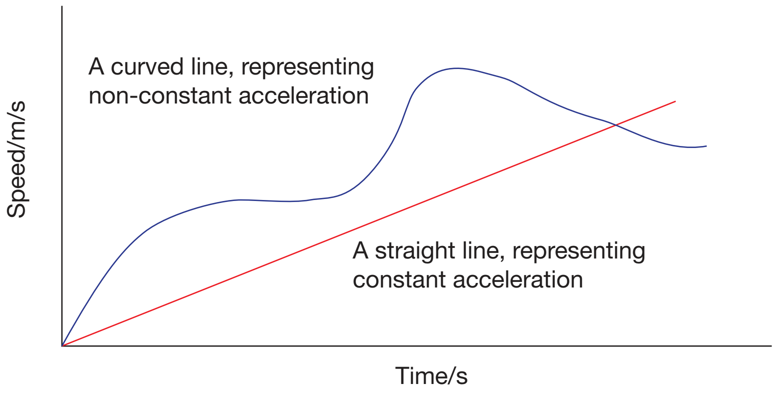

Figure 1.10 Constant and non-constant acceleration

Calculating distance from the speed/time graph

The area under the speed/time graph is equal to the distance travelled. You can find this by calculation, or by a combination of measurement and calculation. When you are using the graph you need to be very careful with the scales.

The speed/time graph for Runner A is shown in Figure 1.11.

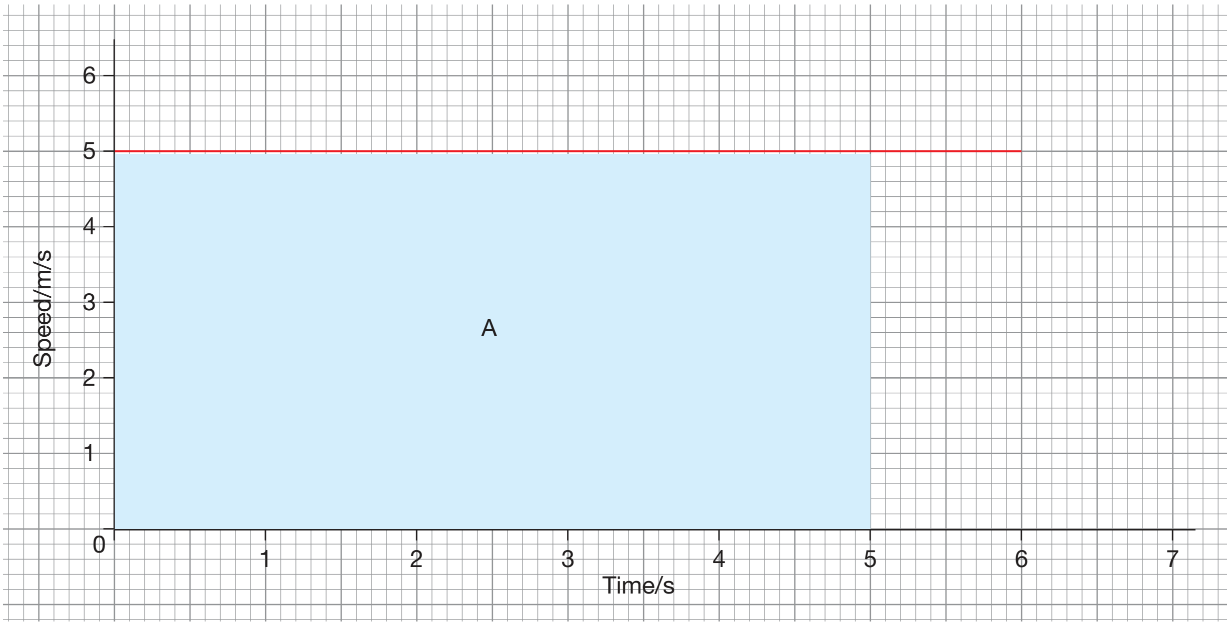

Figure 1.11 Calculating the distance travelled from the area under a speed/time graph for Runner A

To find the distance travelled by Runner A in the first five seconds we can look at the area under the horizontal line – this is the shaded area in Figure 1.11.

We multiply the two sides (5 seconds and 5 m/s) together to give us the total area.

Therefore the distance travelled is $5 \times 5 = 25$ m.

This method can be used to find the distance travelled in more complex cases. Suppose we look at the performance of Runner B and want to know how far she travelled between $t = 0.5$ and $t = 3.5$ s.

On the graph we add together area B and area C.

© The Open School Trust

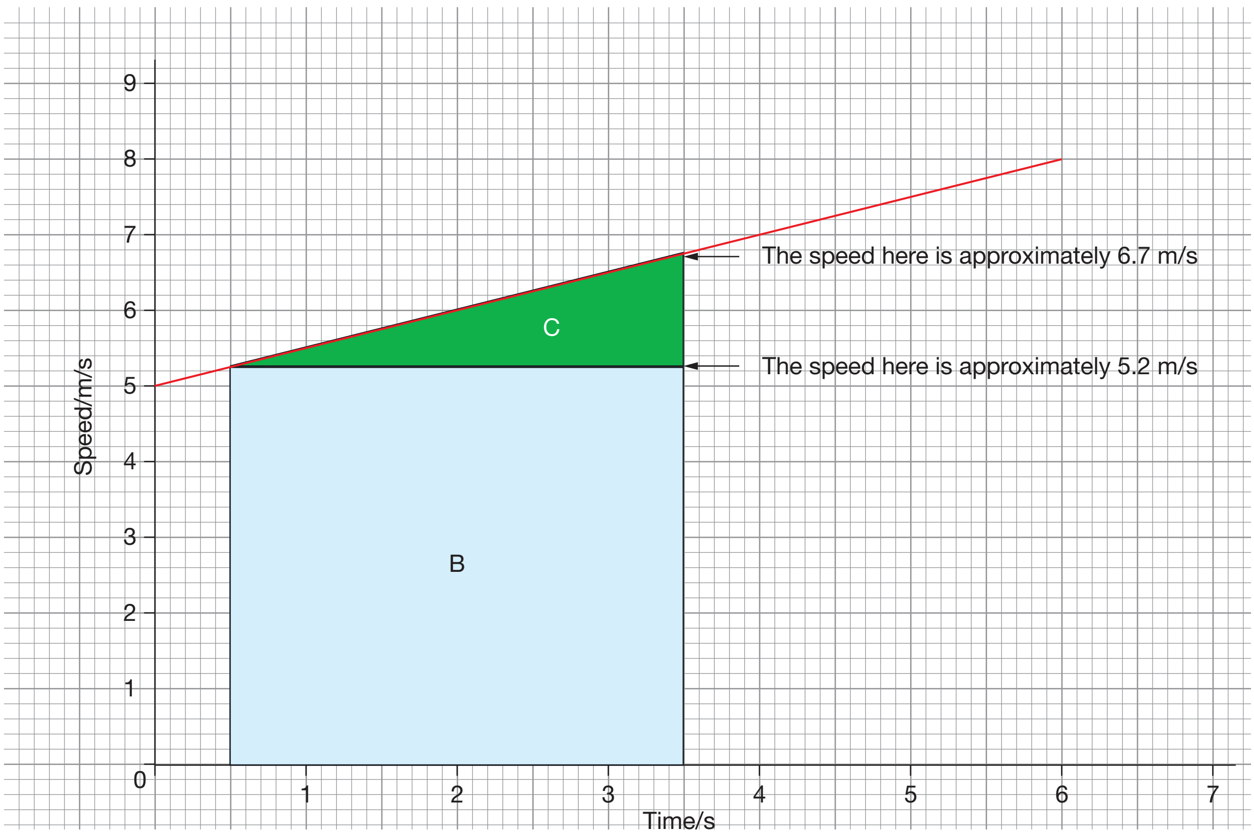

Figure 1.12 Calculating the distance travelled by Runner B

The area of the rectangle B is approximately $5.2 \times 3 = 15.6$ m.

The area of a triangle is half the product of the base length multiplied by the vertical height. So the area of the triangle C is approximately $0.5 \times 3 \times 1.5 = 2.25$ m.

The total distance travelled by Runner B is therefore 17.8 m (it would not be appropriate to claim better accuracy than this, so I have removed the last figure).

© The Open School Trust

Summary

You should now be able to:

- define speed and calculate it from data given
- draw a distance/time graph and use it to find speed
- draw a speed/time graph and use it to find the distance travelled and the acceleration
- calculate acceleration from data given
- recognise a speed/time graph for constant and non-constant acceleration.

Online quiz

Now go online to do Quiz P1.

© The Open School Trust

Feedback to activities

Activity 1

1 Speed = $\frac{7}{2}$ = 3.5 m/s

2 One metre is 100 cm, so the speed = $\frac{100}{5}$ = 20 cm/s

3 Twenty minutes is 20/60 hours, so the speed = 10 divided by $\frac{20}{60}$ = 30 km/h.

Note with this particular example that, if you round off the answer $\frac{20}{60}$ to 0.3, you get a different answer. It is good practice to keep all your figures until the end and then round off if you need to.

Activity 2

You should have got the following. It is possible that you put 10 in each position in the second column in the table. If you did this you were looking at each successive two-second period independently. For this study we want the total distance travelled and the total time.

Time/s	Distance/m
0	0
2	10
4	20
6	30

© The Open School Trust

Activity 3

1 The speed is greatest between B and C; you know this because it's the steepest part of the distance/time graph.

2 The gradient of the graph between B and C is estimated as 10m/s.

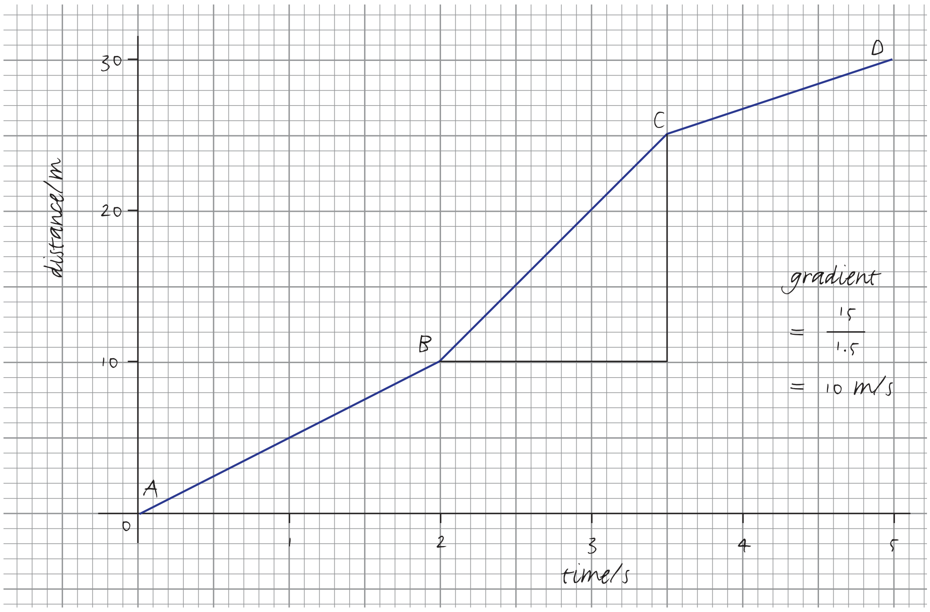

Figure 1.13 Calculating the gradient of section BC

An alternative approach is to read off the points B and C and do the calculation. C is the point 25 m and 3.5 s, B is the point 10 m and 2 s, so the body has travelled 15 m in 1.5 s, giving a speed of 10 m/s.

3 The total distance travelled up to point D is 30 m the total time is 5 s, so the mean speed is $\frac{30}{5}$ = 6 m/s

Activity 4

It is a graph where the line coincides with the *x*-axis, as shown.

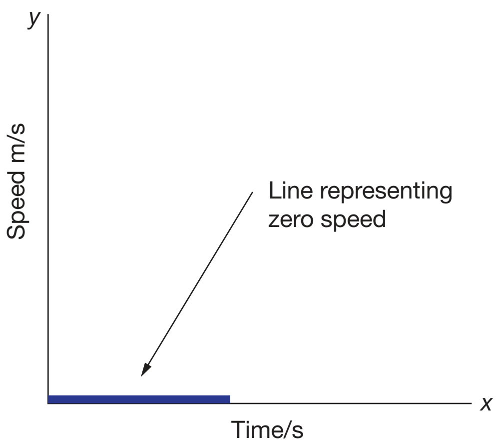

Figure 1.14 A speed/time graph for a body at rest

© The Open School Trust

What next?

We hope this sample has helped you to decide whether this course is right for you.

If you have any further questions, please do not hesitate to contact us using the details below.

If you are ready to enrol, you have different options:

- **enrol online** – for many courses you can enrol online through our website. Just choose your course, click 'enrol now' and then checkout
- **enrol by telephone** – just call our course advice team free on 0800 389 2839 and we can take your details over the telephone
- **pay in full** – you can pay in full with a credit or debit card
- **pay in instalments** – if spreading the cost would be useful, we can arrange that for you. Just call our course advice team to organise this.

Contact us

There are many ways to get in touch if you have any more questions.

Freephone: 0800 389 2839

Email us: info@nec.ac.uk

Website: www.nec.ac.uk

You can also find us Facebook, Twitter and LinkedIn

© 2017 The Open School Trust – National Extension College