Exercise 1.3 Graphs of motion

The following questions will help you to improve your use of graphs and solve problems about journeys.

1 a Figure 1.2 shows a journey made by a pedestrian.

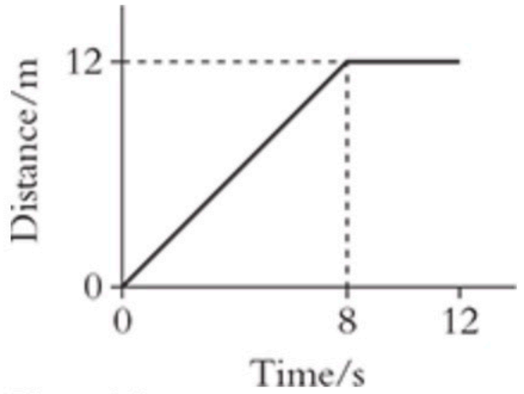

Figure 1.2

7

Use the graph to find the:

i average speed of the pedestrian for the whole journey

ii speed of the pedestrian during the first 8 s.

b Figure 1.3 shows a velocity–time graph for a journey.

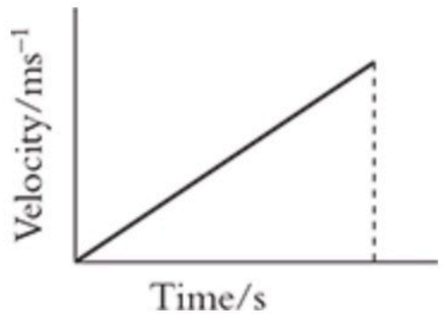

Figure 1.3

What aspect of the journey is shown by the:

i gradient of the graph

ii area under the graph?

2 In an experiment, Lucy measures the displacement of a moving object. Her measurements are shown in Table 1.1. All of Lucy's measurements of displacement have an uncertainty of ±1.0 cm.

Time / s	0.0	1.0	2.0	3.0	4.0	5.0	6.0
Displacement / cm	0.0	2.0	4.0	6.0	8.0	10.0	12.0

Table 1.1

a Use the results in the table to draw a graph of displacement against time.

b Add to your graph appropriate error bars for all points.

c Find, from the graph, the speed at which the object was moving.

d Use the error bars you have drawn to find the maximum and minimum speed of the object.

e Hence state the speed of the object and its uncertainty.

TIP

When drawing graphs, make sure you always label the axes with the correct title and units.

3 The graph in Figure 1.4 shows the velocity of a projectile that is fired vertically upwards from the ground until it momentarily comes to a stop. There are no effects due to air friction.

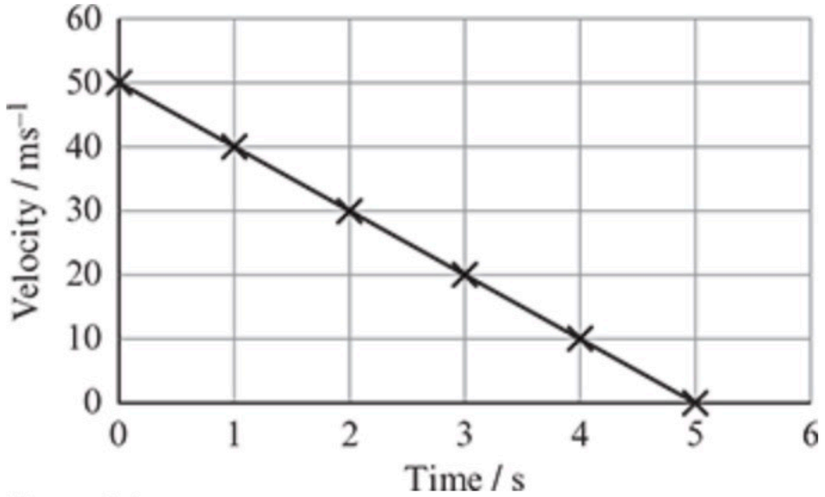

Figure 1.4

a Show that the graph is consistent with the Earth's gravitational acceleration, g, having the value 10 ms^{-2} (1 s.f.)

b Use the graph to calculate the height at which the projectile came to a stop.

c Copy and add to the graph a line to show how the projectile's velocity would change as it returns to the ground.

4 A speedboat moves at a constant speed of 9 ms^{-1} for 5 s, at which time it accelerates at 2 ms^{-2} for 4 s.

a Sketch a graph of the speedboats journey over the 14 s period.

b Use the graph to calculate the distance travelled by the speedboat.

c Show that your answer to part b is consistent with the equation: $s = ut + \frac{1}{2}at^2$

5 Figure 1.5 shows how the velocity of child's toy varies during a 20 s period. At $t = 0$, the toy's velocity = 5 cms^{-1} and at $t = 20$ s, the toy's velocity = −7.5 cms^{-1}.

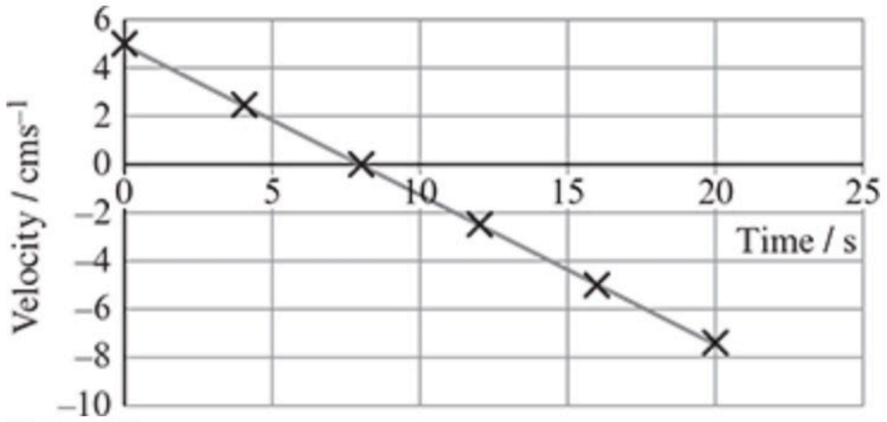

Figure 1.5

a Describe the motion of the toy during the 20 s period.

b Use the graph to calculate the acceleration of the toy.

9

c Use the graph to find the total displacement of the toy.

d **i** How far did the toy actually travel during the 20 s period?

ii Explain why your answers to c and d are different.

6 Table 1.2 shows how the velocity of an object varied during a period of 80 s.

Time / s	0	10	20	30	40	50	60	70	80
Velocity / ms^{-1}	0	2.0	4.0	6.0	6.0	6.0	6.0	3.0	0

Table 1.2

All of the velocity values in the table have an uncertainty of ± 0.5 ms^{-1}.

a Draw a graph of *velocity* against *time* for the motion of the object.

b Use the graph to calculate the total displacement of the object.

c Calculate the acceleration of the object during the first 30 s.

d By adding suitable error bars to your graph find the maximum and minimum values of the acceleration during the first 30 s.

7 Figure 1.6 shows how the acceleration of an initially stationary object varies with time during a 30 s period.

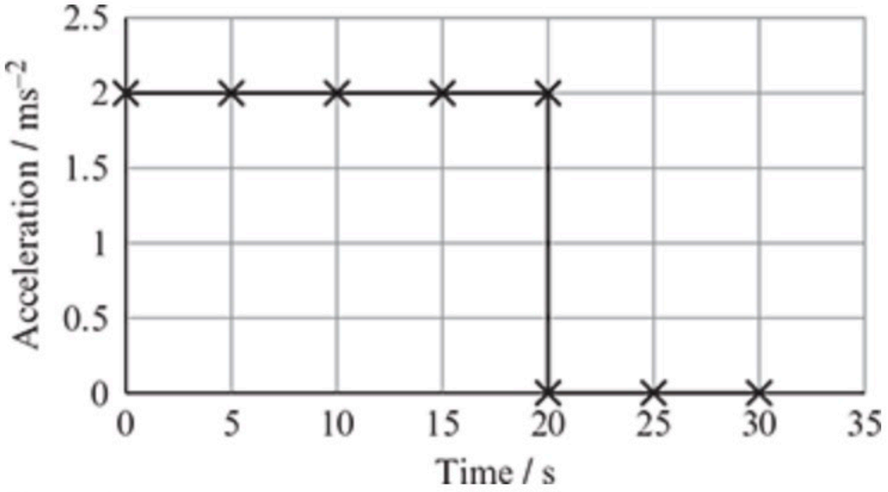

Figure 1.6

a Use the graph to determine the change of velocity of the object during the first 20 s.

b Sketch a graph of *velocity of the object* against *time* for the 30 s period.

c Using your sketch, or otherwise, determine the total displacement of the object.