Motion

1 An average speed camera calculates the average speed of a car by measuring the time it takes to travel between two sensors that are a set distance apart.

A car is travelling down a road, and passes the first sensor of an average speed camera. Just after the car passes the first sensor, the car travels a distance of 740 m in 27 s. It then travels 1400 m in 50 s, and finally travels another 360 m before passing the second sensor. The average speed camera calculates the car's average speed between the sensors as 27.2 m/s.

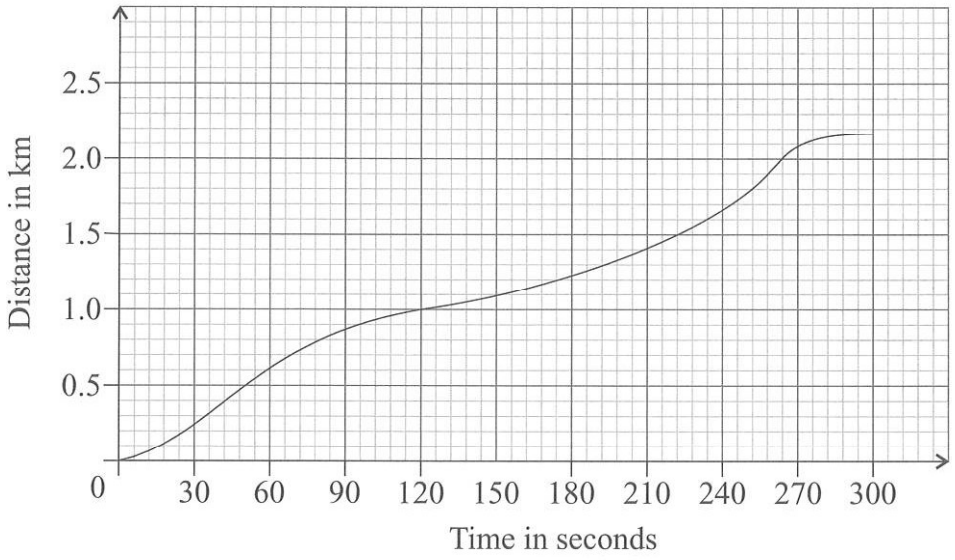
a) Calculate the time it took for the car to travel the last 360 m.
Give your answer to three significant figures.

Time = ... s

[4]

Figure 1 shows the distance/time graph of the first 300 s of the car's journey, before it reached the speed camera.

Figure 1



b) Calculate the maximum speed reached by the car during the first 300 s of the journey.
Give your answer in km/h and to two significant figures.

Speed = ... km/h

[5]

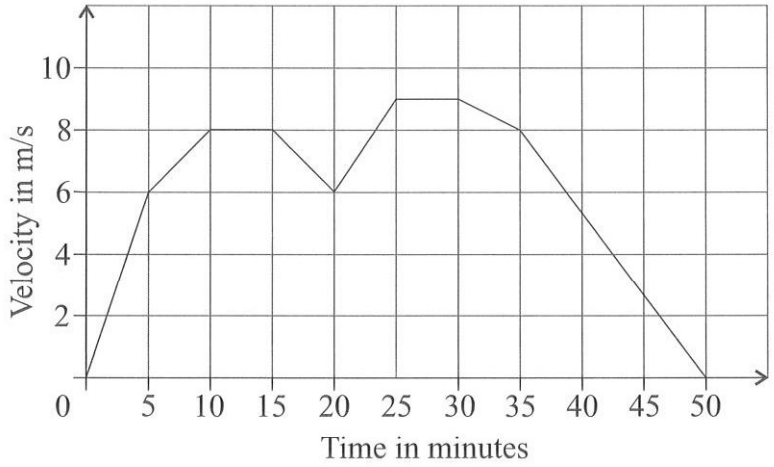
[Total 9 marks]

2 A ferry is carrying passengers between two islands, as shown in **Figure 2**.

Figure 2

The velocity/time graph of the ferry during its journey is shown in **Figure 3**.

Figure 3



a) The speed of boats is often measured in knots. 1 knot ~ 0.5 m/s.
Which of the following is the maximum speed reached by the ferry during its journey?
Tick **one** box.

- ☐ **A** 4.5 knots
- ☐ **B** 18.0 knots
- ☐ **C** 15.5 knots
- ☐ **D** 4.0 knots

[1]

b) Using **Figure 3**, estimate the average speed of the ferry during its journey.

Average speed = ... m/s

[4]

[Total 5 marks]

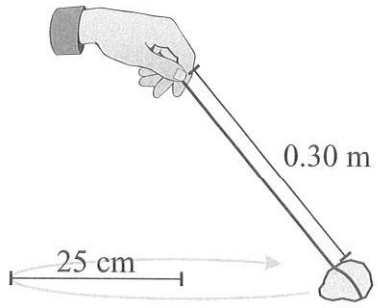
3 A child is throwing stones directly down into a pond from a height of 0.75 m above the surface. It can be assumed that air resistance is negligible and the stone accelerates downwards at 10 m/s^2.

a) A stone is thrown with an initial speed of 1 m/s.
Calculate the time taken for the stone to hit the surface of the water after being thrown.
Give your answer to two significant figures.

Time = ... s
[5]

The child picks up a 75 g stone and ties it to a piece of string.
When at rest, the stone hangs 0.30 m below the child's hand.
The child swings the stone in a horizontal circle of radius 25 cm, as shown in **Figure 4**.

Figure 4



b) In which direction does the resultant force on the stone act?
Tick **one** box.

- ☐ **A** Along the string, away from the child's hand.
- ☐ **B** Horizontally, away from the centre of the stone's circular path.
- ☐ **C** Horizontally, towards the centre of the stone's circular path.
- ☐ **D** Along the string, towards the child's hand.

[1]

c) The stone's speed, v, can be calculated using the equation:

$$v^2 = \frac{r^2 T}{ml}$$

Where r is the radius of the stone's circular path in metres, T is the tension in the string, l is the length of the string in metres and m is the mass of the stone in kilograms.
Given that $T = 0.80$ N, calculate the stone's speed.

v = ... m/s
[5]

[Total 11 marks]

Exam Practice Tip

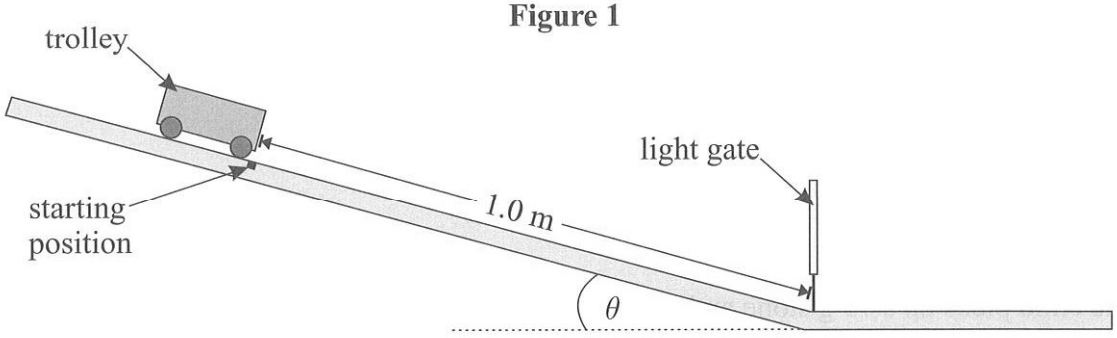
Remember to pay close attention to the labels on graphs. You may be familiar with the quantities the graph is showing, but the units used and the scales of the axes can be more unusual. Make sure you take this into account when reading from the graph and making calculations from it.

Score: ☐ / **25**

More on Motion

1 A student is investigating how the force applied to a trolley affects its acceleration. They use the setup shown in **Figure 1**. The student changes the force on the trolley by altering the angle of the ramp.

Figure 1

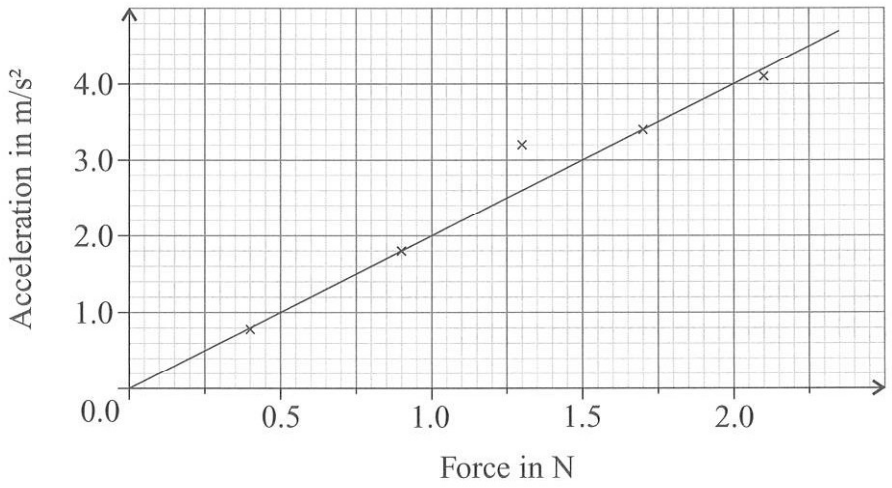


The trolley is held at rest at the starting position. It is released and allowed to roll down the ramp.

The light gate measures the final velocity of the trolley at the bottom of the ramp.
The student uses this to calculate the acceleration down the ramp.
The student also calculates the resultant force acting on the trolley in the direction of its motion.

Figure 2 shows the graph of their results.

Figure 2



a) Using **Figure 2**, determine the inertial mass of the trolley.

Inertial mass = ... kg
[3]

When the resultant force was 1.3 N, the student recorded an anomalous result for acceleration.
This was because the trolley had a non-zero initial velocity.
At a force of 1.3 N, the light gate recorded a final velocity of 2.53 m/s.

b) Using **Figure 2**, calculate the initial velocity of the trolley for the anomalous result.
Give your answer to two significant figures.

Initial velocity = ... m/s
[5]

This experiment can be used to model the behaviour of a car as it rolls down a hill.
Assuming friction is negligible and the only force acting to move a car down a hill is its weight, a car will accelerate down a hill with an incline of 10° at approximately 1.8 m/s^2.

c) Estimate the size of the braking force which must be applied in order for a car to remain at a constant speed as it rolls down a hill with a 10° incline.

Force = ... N
[3]

[Total 11 marks]

2 A parachutist falling towards the Earth exerts an attractive force of 680 N on the Earth. Explain the cause of this force and explain why the Earth does not noticeably move towards the person.

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[Total 4 marks]

Score: ☐/15