Velocity and Acceleration

1 A cyclist travels 1500 m from his house to his local shops in 300 seconds.

a) State the equation linking average speed, distance moved and time taken.

.....

[1]

b) Calculate the cyclist's average speed during his journey.

Average speed = ... m/s

[2]

c) On the return home, the cyclist accelerates from 2.0 m/s with a steady acceleration of 2.4 m/s^2. Calculate the time it takes the cyclist to reach 10 m/s.

Time = ... s

[4]

[Total 7 marks]

2 A coin is rolled along a balcony edge at a steady speed of 0.46 m/s before falling off the edge after 2.4 seconds. It then accelerates due to gravity and hits the ground after 8.0 seconds at a speed of 78.4 m/s. Assume no air resistance acts on the coin.

a) Calculate how far the coin rolls before falling off the edge of the balcony.

Distance = ... m

[3]

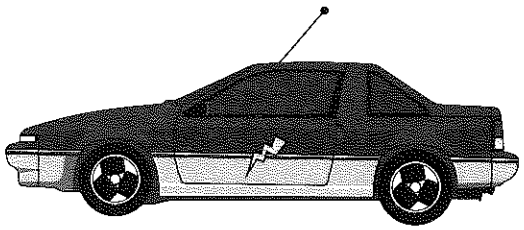
b) Calculate the acceleration of the coin during its fall.

Acceleration = ... m/s^2

[3]

[Total 6 marks]

3 A model car company produces battery-powered model cars.
Their latest model accelerates from rest to 20 m/s in 3.5 s, and has a top speed of 25 m/s.



a) Calculate the acceleration of the model car during these 3.5 seconds.

Acceleration = ... m/s^2
[3]

b) Calculate how fast the car would be moving if it travelled with the acceleration in part a) from rest for 1.5 seconds.

Velocity = ... m/s
[3]

[Total 6 marks]

4 A tractor ploughing a field accelerates at 3 m/s^2 for 1.2 seconds, after which its velocity is 5 m/s.

a) Calculate the tractor's velocity before it started accelerating.

Velocity = ... m/s
[4]

b) As the tractor approaches the end of the field, it turns at a constant speed until it's facing the opposite direction. State whether the tractor accelerates during this time and explain your answer.

.....

.....
[1]

[Total 5 marks]

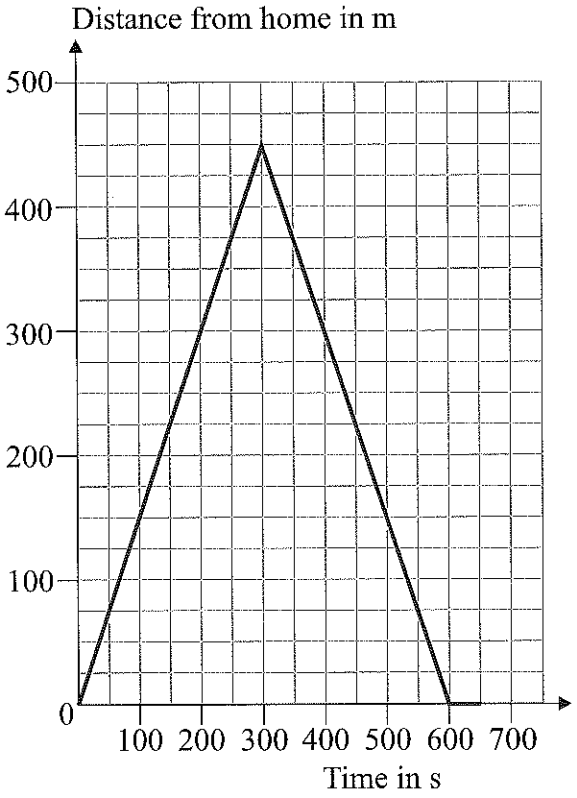
Exam Practice Tip

Acceleration and velocity questions are exam favourites so make sure you're happy doing all the questions in this topic. You won't be given any of the formulas you've used on these last two pages in the exam, so make sure you really know them back to front, how to rearrange them and the units of each of the terms.

Score ☐ / **24**

D-T and V-T Graphs

1 A student walks to football training but finds she has left her boots at home. She turns around and walks back home, where she spends 50 seconds looking for the boots. Below is a distance-time graph for her journey.



a) Use the graph to find the time it took for the student to walk to training.

Time = ... s
[1]

b) State whether the student walked to training at a steady speed. Explain how you know.

.....

.....

.....

.....

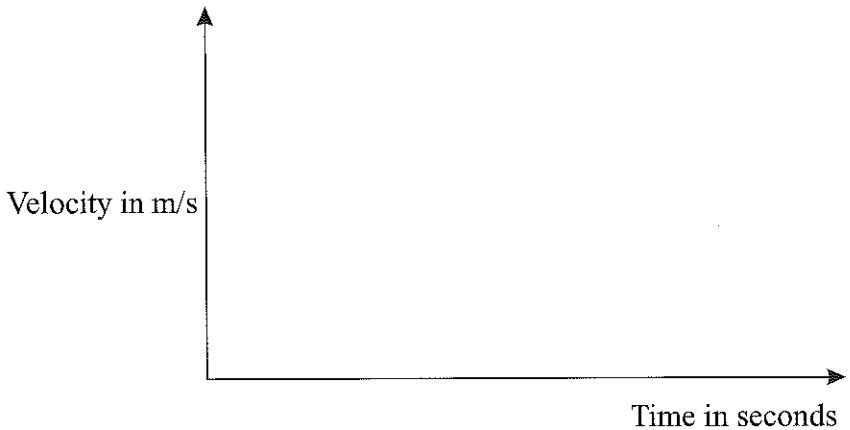
.....
[2]

c) Use the graph to calculate the student's average speed as she walked to football training.

Average speed = ... m/s
[3]

d) The student returns home after training in a car. During the journey, the car constantly accelerates for 10 s to overtake another vehicle and then travels at a constant speed for a further 30 s.

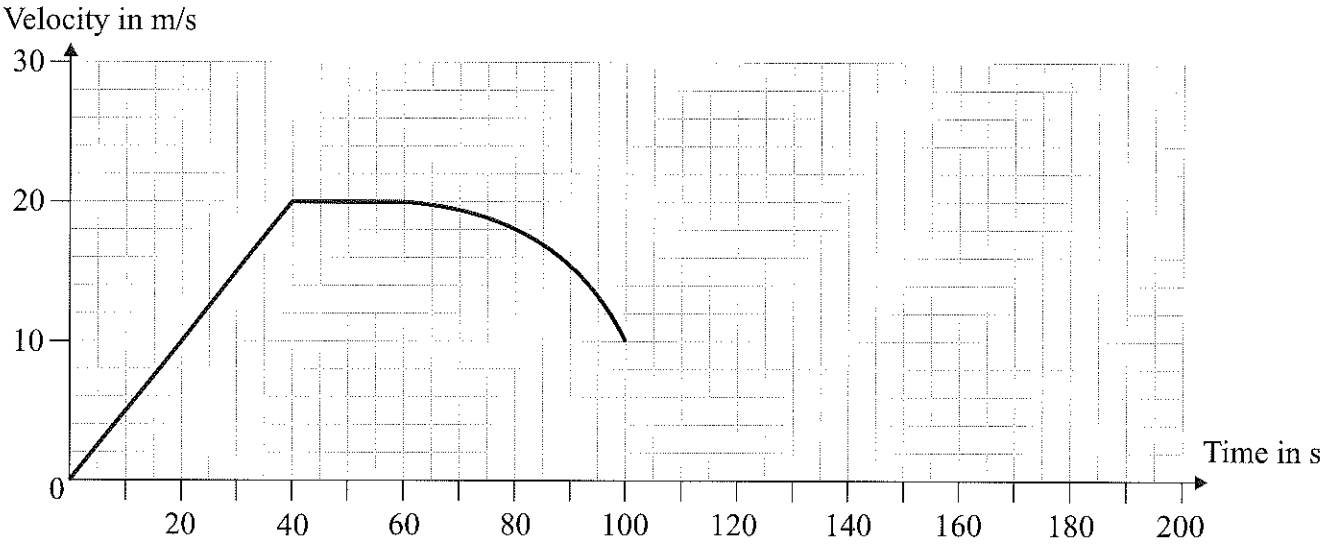
On the axes below, sketch a velocity-time graph to show the motion of the car during this time.



[3]

[Total 9 marks]

2 The diagram shows a velocity-time graph for a car during a section of a journey.



a) Describe the motion of the car during the following parts of the journey.

i) Between 40 and 60 seconds.

.....

[1]

ii) Between 60 and 100 seconds.

.....

[1]

b) Calculate the distance travelled by the car between 40 and 60 seconds.

Distance travelled = ... m

[3]

c) Calculate the acceleration of the car between 0 and 40 seconds.

Acceleration = ... m/s^2

[3]

d) After 100 seconds, the car accelerates steadily for 40 seconds until it reaches a steady velocity of 30 m/s, which it maintains for 60 seconds. Complete the graph to show this motion.

[2]

[Total 10 marks]

Score: ☐/**19**

☹ ☐ 😐 ☐ 🙂 ☐

Section 1 — Forces and Motion

Pages 3-4: Velocity and Acceleration

1 a) average speed = $\frac{\text{distance moved}}{\text{time taken}}$ ($s = \frac{d}{t}$) ***[1 mark]***

b) average speed = $\frac{1500}{300}$ = **5 m/s**

[2 marks if answer correct, otherwise 1 mark for correct substitution of values into the equation.]

c) $a = \frac{v-u}{t} \Rightarrow t = \frac{v-u}{a} = \frac{10-2}{2.4}$ = **3.3 s (to 2 s.f.)**

[4 marks if answer correct, otherwise 1 mark for using the correct equation, 1 mark for correct rearrangement of the equation and 1 mark for correct substitution of values into the equation.]

2 a) $s = \frac{d}{t} \Rightarrow d = s \times t = 0.46 \times 2.4$ = **1.1 m (to 2 s.f.)**

[3 marks if answer correct, otherwise 1 mark for using the correct equation and 1 mark for correct rearrangement of the equation and correct substitution of values into the equation.]

b) acceleration = $\frac{\text{change in velocity}}{\text{time taken}} = \frac{78.4}{8.0}$ = **9.8 m/s²**

[3 marks if answer correct, otherwise 1 mark for using the correct equation and 1 mark for correct substitution of values into the equation.]

3 a) $a = \frac{v-u}{t} = \frac{20}{3.5}$ = **5.7 m/s² (to 2 s.f.)**

[3 marks if answer correct, otherwise 1 mark for using the correct equation and 1 mark for correct substitution of values into the equation.]

b) $a = \frac{v-u}{t} \Rightarrow v = (a \times t) + u = (5.7 \times 1.5) + 0$ = **8.55 m/s**

[3 marks if answer correct, otherwise 1 mark for correct rearrangement of the equation and 1 mark for correct substitution of values into the equation.]

4 a) $a = \frac{v-u}{t} \Rightarrow u = v - (a \times t) = 5 - (3 \times 1.2)$
= **1.4 m/s**

[4 marks if answer correct, otherwise 1 mark for using the correct equation, 1 mark for correct rearrangement of the equation and 1 mark for correct substitution of values into the equation.]

b) Yes — the tractor has changed direction, so there has been a change in velocity (and so there must have been an acceleration) ***[1 mark]***.

Pages 5-6: D-T and V-T Graphs

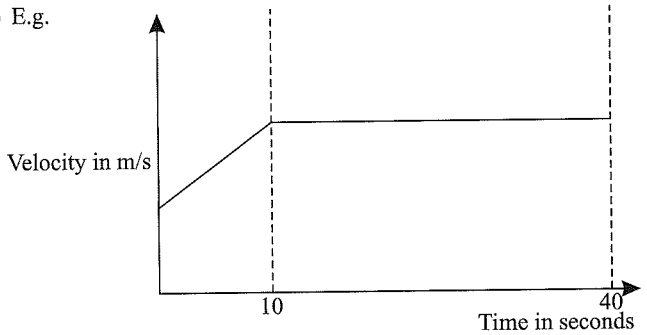
1 a) 300 s ***[1 mark]***

b) Yes — the gradient of the graph shows the student's speed ***[1 mark]*** and the gradient for this part of the journey is constant (it's a straight line) ***[1 mark]***.

c) average speed = $\frac{\text{distance moved}}{\text{time taken}} = \frac{450}{300}$ = **1.5 m/s**

[3 marks if answer correct, otherwise 1 mark for using the correct equation and 1 mark for correct substitution of values in the equation.]

d) E.g.



[3 marks available — 1 mark for a straight, sloped line showing the initial acceleration, 1 mark for a straight horizontal line showing the constant speed, and 1 mark for plotting a horizontal line for roughly 3 times the time the sloped line is plotted over.]

2 a) i) Travelling at a steady velocity (20 m/s) ***[1 mark]***.

ii) E.g. Slowing down / (increasing) deceleration ***[1 mark]***.

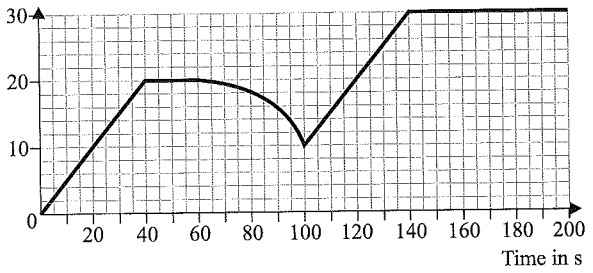
b) Distance travelled = area under graph
= (60 – 40) × (20 – 0)
= **400 m**

[3 marks for the correct answer, otherwise 1 mark for attempting to find the area under the graph between 40 and 60 seconds, 1 mark for correctly showing (60 – 40) × 20 or 20 × 20.]

c) Acceleration = gradient = $\frac{20-0}{40-0}$ = **0.5 m/s²**

[3 marks for the correct answer, otherwise 1 mark for attempting to find the gradient, 1 mark for dividing a correct change in velocity by a correct change in time in the time range 0 – 40 s.]

d) Velocity in m/s



[1 mark for a straight line with a positive gradient between 100 and 140 seconds, 1 mark for a straight horizontal line between 140 and 200 seconds.]

Page 7: Mass, Weight and Gravity

1 a) i) Weight = mass × gravitational field strength ($W = m \times g$) ***[1 mark]***

ii) $W = m \times g \Rightarrow g = \frac{W}{m} = \frac{19.6}{2}$
= **9.8 newtons per kilogram (N/kg)**

[3 marks if answer correct, otherwise 1 mark for correct rearrangement of the equation and correct substitution of values into the equation, and 1 mark for correct unit. Allow m/s² as a correct unit.]

b) The weight would be smaller ***[1 mark]*** as the gravitational field strength, g, is lower on the moon ***[1 mark]***.

Page 8: Forces and Friction

1 a) gravitational ***[1 mark]***

b) frictional ***[1 mark]***, electrostatic ***[1 mark]***, newtons ***[1 mark]***