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IGCSE · Cambridge (CIE) · Further Maths

🕐 1 hour   ❓ 14 questions
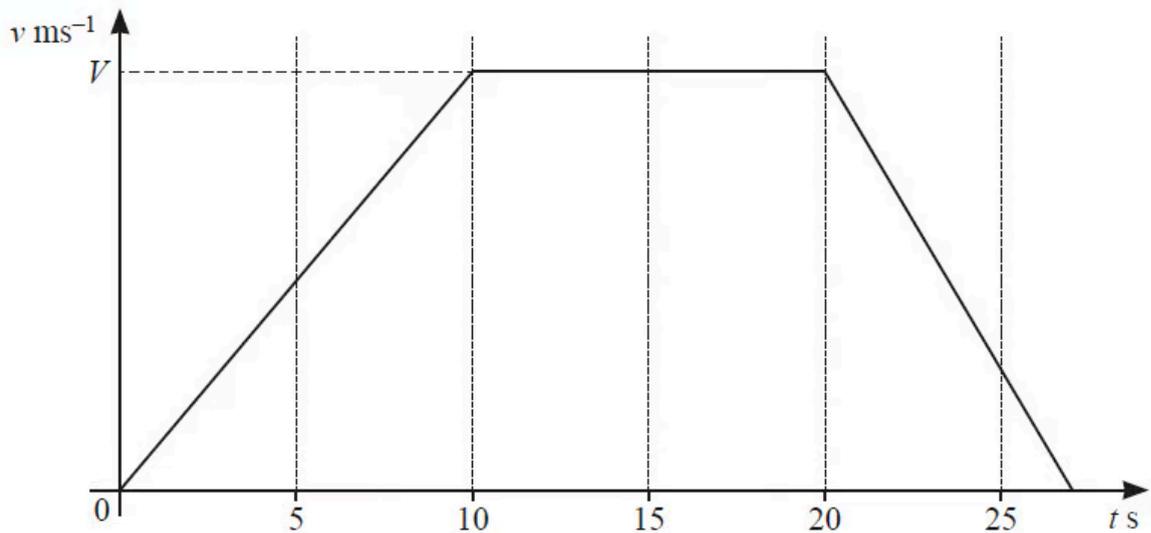
Exam Questions

Calculus for Kinematics

Kinematics Toolkit / Calculus for Kinematics / Sketching Travel Graphs

Medium (5 questions)	/26
Hard (8 questions)	/49
Very Hard (1 question)	/8
Total Marks	**/83**

Medium Questions

1

The diagram shows the velocity–time graph for a particle Q travelling in a straight line with velocity $v\,\text{ms}^{-1}$ at time t s. The particle accelerates at $3.5\,\text{ms}^{-2}$ for the first 10 s of its motion and then travels at constant velocity, $V\,\text{ms}^{-1}$, for 10 s. The particle then decelerates at a constant rate and comes to rest. The distance travelled during the interval $20 \leq t \leq 25$ is 112.5 m.

(i) Find the value of V.
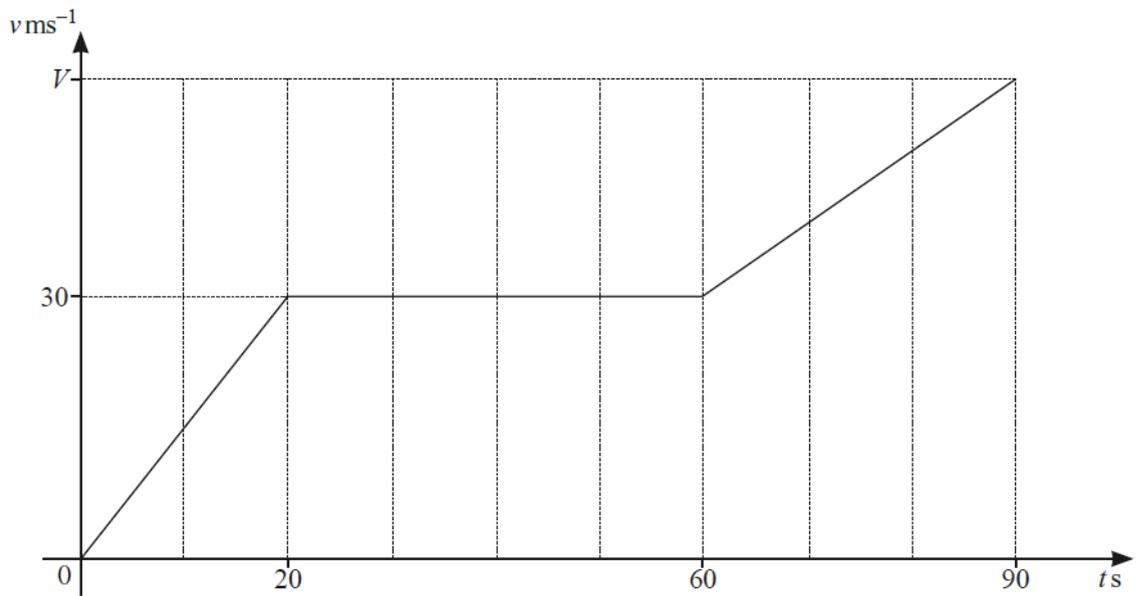
[1]

(ii) Find the velocity of Q when $t = 25$.

[3]

(iii) Find the value of t when Q comes to rest.

[3]

2

The diagram shows the velocity–time graph of a particle P that travels 2775 m in 90 s, reaching a final velocity of $V\,\mathrm{ms}^{-1}$.

(i) Find the value of V.

[3]

(ii) Write down the acceleration of P when $t = 40$.

[1]

(4 marks)

3 The displacement, x m, of a particle from a fixed point at time t s is given by

$$x = 6\cos\left(3t + \frac{\pi}{3}\right).$$

Find the acceleration of the particle when $t = \frac{2\pi}{3}$.

(3 marks)

4 (a) A particle P moves in a straight line such that, t seconds after passing through a fixed point O, its acceleration, a ms^{-2}, is given by $a = -6$. When $t = 0$, the velocity of P is 18 ms^{-1}.

Find the time at which P comes to instantaneous rest.

(3 marks)

(b) Find the distance travelled by P in the 3rd second.

(3 marks)

5 The acceleration, a ms^{-2}, of a particle Q travelling in a straight line, is given by $a = 6\cos 2t$ at time t s. When $t = 0$ the particle is at point O and is travelling with a velocity of 10 ms^{-1}.
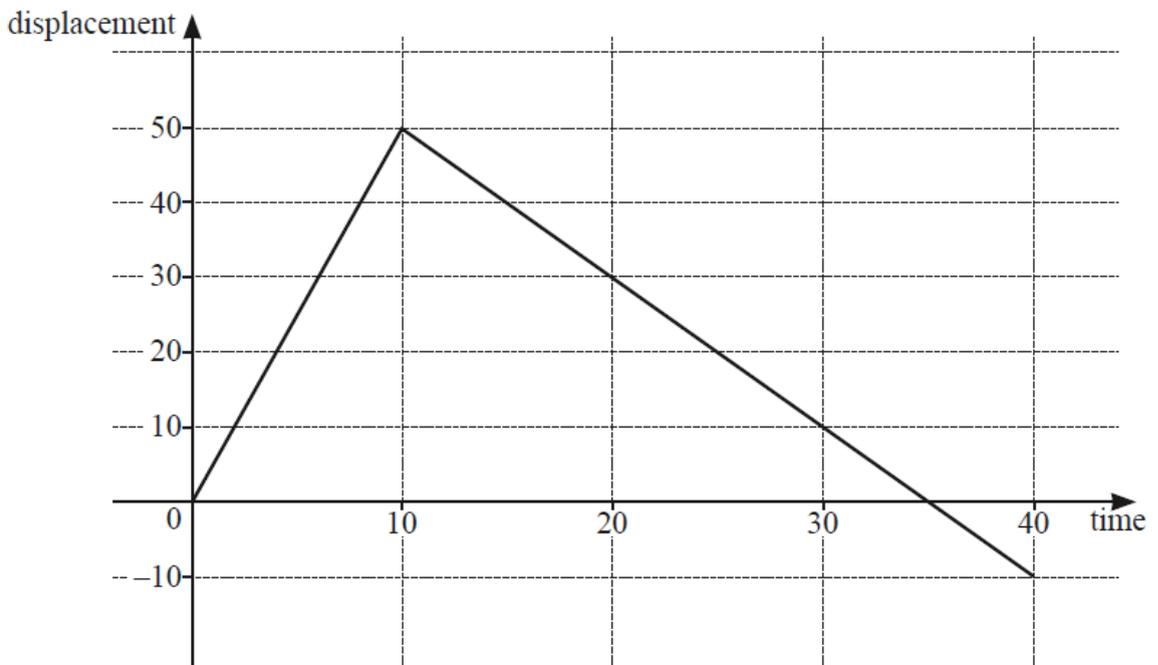
(i) Find the velocity of Q at time t.

[3]

(ii) Find the displacement of Q from O at time t.

[3]

(6 marks)

Hard Questions

1 In this question, all lengths are in metres and time, t, is in seconds.

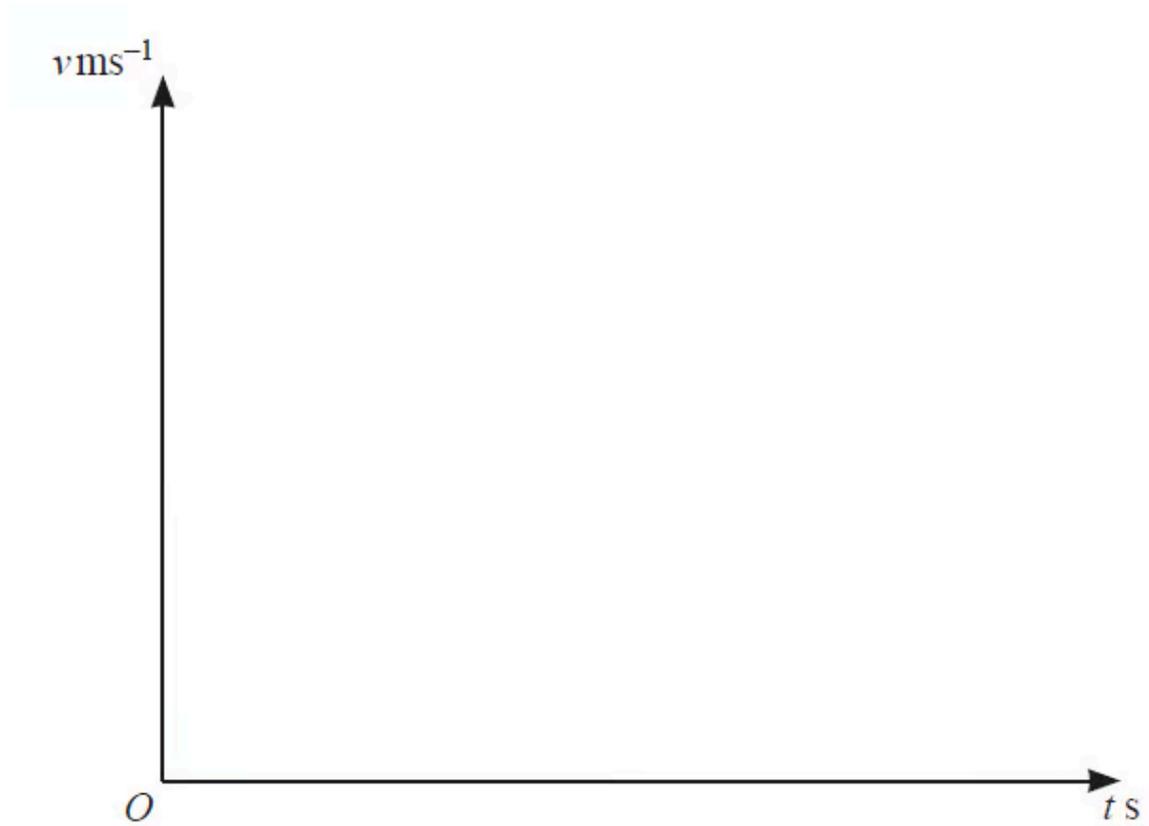The diagram shows the displacement–time graph for a runner, for $0 \leqslant t \leqslant 40$.

(i) Find the distance the runner has travelled when $t = 40$.

(ii) On the axes, draw the corresponding velocity–time graph for the runner, for $0 \leqslant t \leqslant 40$.

(3 marks)

2 (a) A particle travels in a straight line. As it passes through a fixed point O, the particle is travelling at a velocity of 3 ms^{-1}. The particle continues at this velocity for 60 seconds then decelerates at a constant rate for 15 seconds to a velocity of 1.6 ms^{-1}. The particle then decelerates again at a constant rate for 5 seconds to reach point A , where it stops.

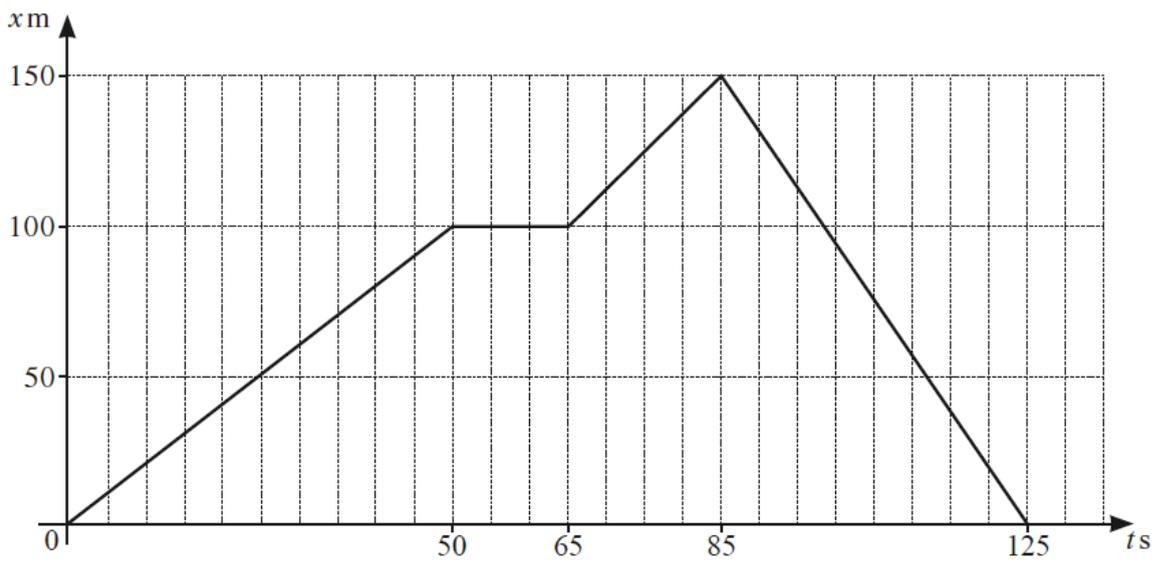Sketch the velocity-time graph for this journey on the axes below.

$v\,\mathrm{ms}^{-1}$

O

$t\,\mathrm{s}$

(3 marks)

(b) Find the distance between O and A.

(3 marks)

(c) Find the deceleration in the last 5 seconds.
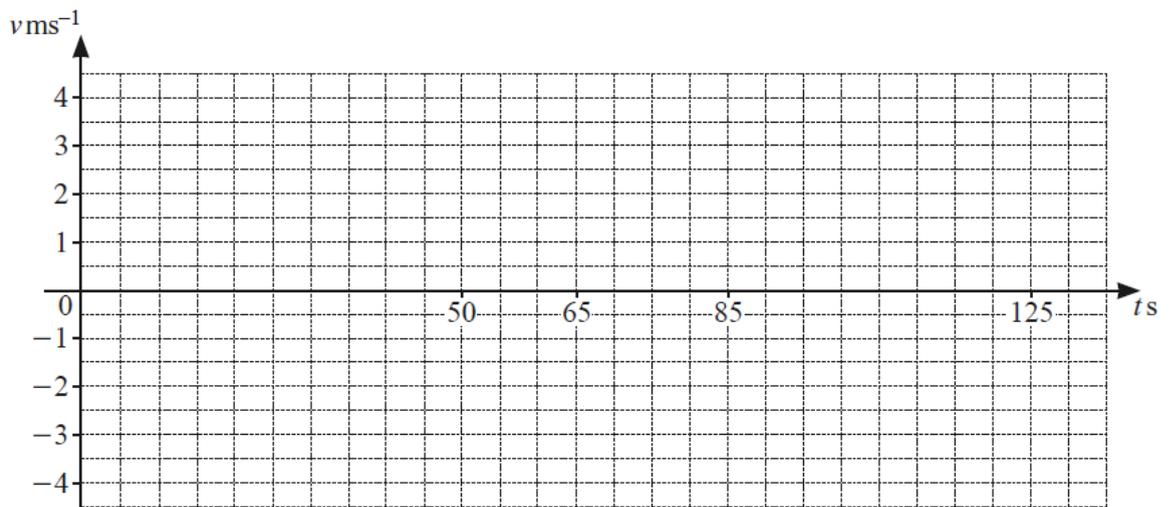
(1 mark)

3

The diagram shows the $x-t$ graph for a runner, where displacement, x, is measured in metres and time, t, is measured in seconds.

(i) On the axes below, draw the $v-t$ graph for the runner.

[3]

(ii) Find the total distance covered by the runner in 125 s.

[1]

4 A particle P moves in a straight line such that its displacement, x m, from a fixed point O at time t s is given by $x = 10 \sin 2t - 5$.

(i) Find the speed of P when $t = \pi$.

[1]

(ii) Find the value of t for which P is first at rest.

[2]

(iii) Find the acceleration of P when it is first at rest.

[2]

(5 marks)

5 (a) In this question, the units are metres and seconds. A particle P is travelling in a straight line.

Its acceleration, a, away from a fixed point O, at time t, is given by $a = (3t + 2)^{-\frac{1}{3}}$, where $t \geqslant 0$. When $t = 2$, P is travelling with a velocity of 8 and has a displacement of -4.8 from O.

Find an expression for the velocity of P at time t.

(b) Explain why P is never at rest.

(c) Find the displacement of P from O when $t = \dfrac{25}{3}$.

(4 marks)

6 A particle, P, moves in a straight line such that its displacement from a fixed point at time t is s.

The acceleration of P is given by $(2t + 4)^{-\frac{1}{2}}$, for $t > 0$

(i) Given that P has a velocity of 9 when $t = 6$, find the velocity of P at time t.

(ii) Given that s = $\dfrac{1}{3}$ when $t = 6$, find the displacement of P at time t.

(6 marks)

7 (a) At time t s, a particle travelling in a straight line has acceleration $(2t+1)^{-\frac{1}{2}}$ ms^{-2}. When $t = 0$, the particle is 4 m from a fixed point O and is travelling with velocity 8 ms^{-1} away from O.

Find the velocity of the particle at time t s.

(3 marks)

(b) Find the displacement of the particle from O at time t s.

(4 marks)

8 (a) A particle travels along a straight line with a velocity, v ms^{-1}, given by

$$v = 6\left(t - \frac{1}{2}\right)^2 + \frac{5}{2}$$

for $t \geq 0$ where t is time in seconds. The particle has an initial displacement of -1 metres.

Find the acceleration after 2 seconds.

(4 marks)

(b) Find the displacement after 2 seconds.

(4 marks)

(c) Explain why a velocity-time graph and a speed-time graph will always be the same for this particle.

(1 mark)

Very Hard Questions

1 (a) A particle moves in a straight line such that, t seconds after passing a fixed point O, its displacement from O is s m, where $s = e^{2t} - 10\,e^t - 12t + 9$.

Find expressions for the velocity and acceleration at time t.

(3 marks)

(b) Find the time when the particle is instantaneously at rest.

(3 marks)

(c) Find the acceleration at this time.

(2 marks)