3.1 Mechanics: Quantities, Units and Kinematics: 1-hour Pack

Total Marks

EDEXCEL 9MA0 · Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Convert a time of 2 hours 15 minutes into seconds.

(Total for Question 1 is 1 mark)

---

2 A stone is released from rest at the top of a vertical cliff and hits the sea 3.2 s later. The stone is modelled as a particle moving freely under gravity, with $g = 9.8$ m/s^2.

(a) Find the speed with which the stone hits the sea. **(2)**

(b) Find the height of the cliff above sea level. **(3)**

(c) State one modelling assumption, other than that the stone is a particle, that has been used in this question. **(1)**

(d) A second, identical stone is thrown vertically downwards from the same point on the cliff with initial speed 5 m/s. Using the height found in part (b), find how long this second stone takes to reach the sea, giving your answer to 3 significant figures. **(3)**

(Total for Question 2 is 9 marks)

---

3 A ball is released from rest and falls freely under gravity, $g = 9.8$ m/s^2. Find its speed after falling for 1 second.

(Total for Question 3 is 1 mark)

---

4 A particle has initial speed 3 m/s and accelerates uniformly at 2 m/s^2 for 9 seconds. Find its final speed.

(Total for Question 4 is 2 marks)

---

5 A cyclist accelerates uniformly from 2 m/s to 14 m/s in 4 seconds. Find the acceleration.

(Total for Question 5 is 2 marks)

© Revision Library | revisionlibrary.co.uk

6 A car decelerates uniformly from 24 m/s to rest in 6 seconds. Find the distance travelled while decelerating.

(Total for Question 6 is 2 marks)

---

7 A particle moves with initial speed 2 m/s and constant acceleration 3 m/s^2. Find the distance it travels in the first 4 seconds.

(Total for Question 7 is 2 marks)

---

8 A particle accelerates uniformly from 5 m/s to 13 m/s while travelling 36 m. Find the acceleration.

(Total for Question 8 is 2 marks)

---

9 A particle moves in a straight line with constant acceleration. It passes through a point A with speed 4 m/s and, 6 seconds later, passes through a point B with speed 19 m/s. The distance AB is d metres.

(a) Find the acceleration of the particle. **(2)**

(b) Show that d = 69. **(3)**

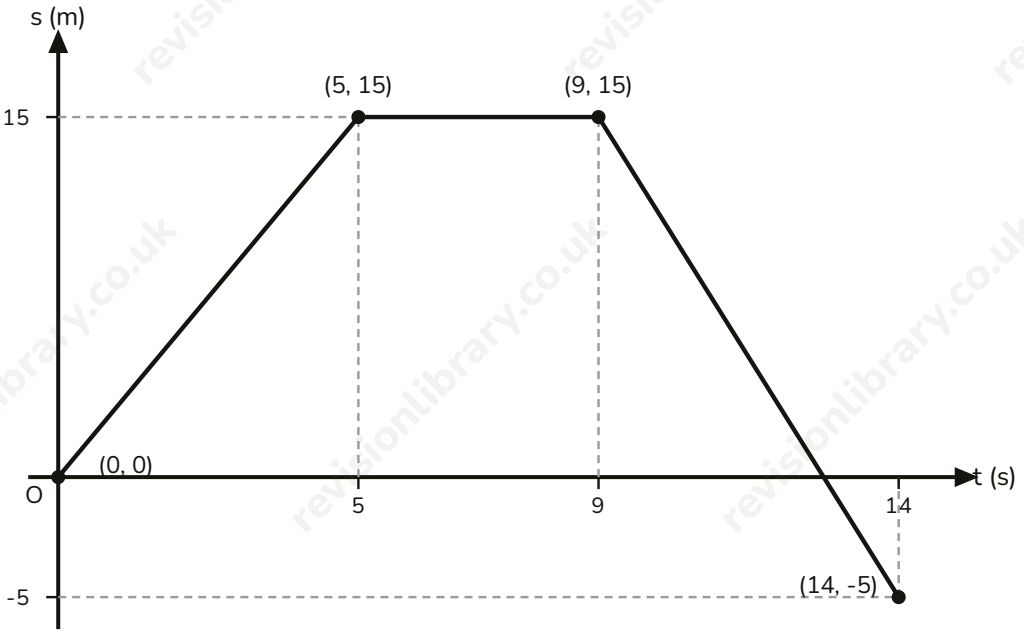
(c) The particle continues to move with the same constant acceleration. Find the speed of the particle 2 seconds after it passes through B. **(2)**

(d) Find the total distance travelled by the particle from A until 2 seconds after it passes through B. **(3)**

(Total for Question 9 is 10 marks)

© Revision Library | revisionlibrary.co.uk

10 A remote-controlled toy car moves along a straight track. Its displacement s metres from a fixed point O at time t seconds is shown in the displacement-time graph, which consists of three straight line segments joining the points (0, 0), (5, 15), (9, 15) and (14, -5).



(a) State what feature of a displacement-time graph represents the velocity of the car. **(1)**

(b) Find the velocity of the car during the interval $0 \leq t \leq 5$. **(2)**

(c) Describe the motion of the car during the interval $5 \leq t \leq 9$. **(1)**

(d) Find the velocity of the car during the interval $9 \leq t \leq 14$, and state what the sign of your answer tells you about its direction of motion. **(3)**

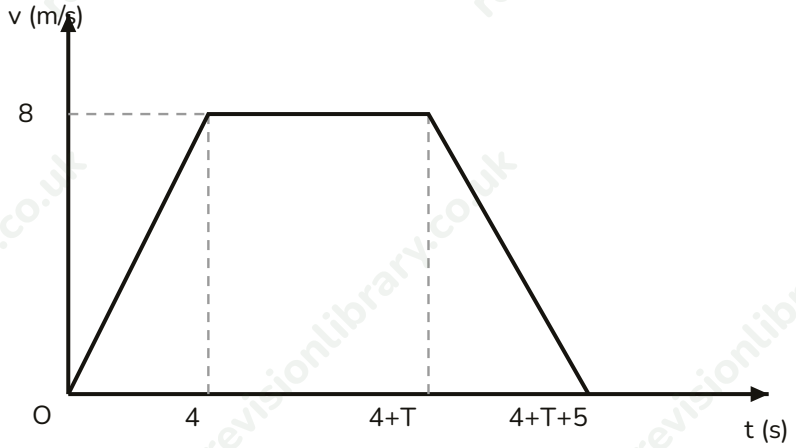
(e) Find the value of t at which the car passes through O. **(3)**

(f) Find the total distance travelled by the car during the interval $0 \leq t \leq 14$. **(3)**

(Total for Question 10 is 13 marks)

© Revision Library | revisionlibrary.co.uk

11 A cyclist sets off from rest and accelerates uniformly to a speed of 8 m/s over the first 4 seconds of her journey. She then travels at this constant speed for a further T seconds, before decelerating uniformly to rest over the next 5 seconds. The velocity-time graph for her journey is shown below. Given that the total distance she travels is 100 m, find the value of T.



(Total for Question 11 is 4 marks)

© Revision Library | revisionlibrary.co.uk

Mark scheme · 3.1 Mechanics: Quantities, Units and Kinematics: 1-hour Pack

Question 1

8100 cao **B1**

Answer: 8100 s

Question 2

(a) v = u + at with u=0, a=9.8, t=3.2 **M1**

(a) awrt 31.4 m/s **A1**

(a) Answer: 31.4 m/s (3 s.f.)

(b) s = ut + 1/2 a t^2 with u=0, a=9.8, t=3.2 **M1**

(b) s = 0.5*9.8*3.2^2 correctly evaluated **M1**

(b) awrt 50.2 m **A1**

(b) Answer: 50.2 m (3 s.f.)

(c) any valid assumption, e.g. air resistance is negligible / g is constant near the Earth's surface / the motion is vertical **B1**

(c) Answer: Air resistance on the stone is negligible (oe).

(d) form $4.9t^2 + 5t - 50.176 = 0$ (or equivalent using $s=ut+1/2at^2$) **M1**

(d) solve using the quadratic formula and reject the negative root **M1**

(d) awrt 2.73 s **A1**

(d) Answer: 2.73 s (3 s.f.)

Question 3

9.8 cao **B1**

Answer: 9.8 m/s

Question 4

use v = u + at with u=3, a=2, t=9 **M1**

21 m/s cao **A1**

Answer: 21 m/s

Question 5

a = (14-2)/4 **M1**

3 m/s^2 cao **A1**

Answer: 3 m/s^2

Question 6

s = 1/2(u+v)t with u=24, v=0, t=6 **M1**

72 m cao **A1**

Answer: 72 m

Question 7

s = ut + 1/2 a t^2 with u=2, a=3, t=4 **M1**

32 m cao **A1**

Answer: 32 m

Question 8

use $v^2 = u^2 + 2as$ with u=5, v=13, s=36 **M1**

2 m/s^2 cao **A1**

Answer: 2 m/s^2

Question 9

(a) a = (19-4)/6 **M1**

(a) 2.5 m/s^2 cao **A1**

(a) Answer: 2.5 m/s^2

(b) use s = ut + 1/2 a t^2 with u=4, a=2.5 (ft from (a)), t=6 **M1**

(b) s = 4*6 + 0.5*2.5*36 evaluated **M1**

(b) cso: d = 24+45 = 69 **A1**

(b) Answer: d = 69 m (shown)

(c) v = 19 + 2.5*2 **M1**

(c) 24 m/s cao **A1**

(c) Answer: 24 m/s

(d) total time from A = 6+2 = 8 s **M1**

(d) s = 4*8 + 0.5*2.5*8^2 (or 69 + distance B to final point) **M1**

(d) 112 m cao **A1**

(d) Answer: 112 m

Question 10

(a) the gradient (slope) of the graph **B1**

(a) Answer: The gradient of the displacement-time graph.

(b) gradient = (15-0)/(5-0) **M1**

(b) 3 m/s cao **A1**

(b) Answer: 3 m/s

(c) the car is stationary (at rest), remaining 15 m from O **B1**

(c) Answer: The car is stationary, 15 m from O.

(d) gradient = (-5-15)/(14-9) **M1**

(d) -4 m/s cao **A1**

(d) the negative sign shows the car is moving in the negative direction (back towards and past O) **B1**

(d) Answer: -4 m/s; the car is moving in the negative direction, back towards and through O.

(e) set up a linear equation for the third segment, e.g. s = 15 - 4(t-9), ft from (d) **M1**

(e) solve 15 - 4(t-9) = 0 **M1**

(e) t = 12.75 cao **A1**

(e) Answer: t = 12.75 s

(f) distance in the first segment = 15 (0 to 5), distance in the second segment = 0 (5 to 9) **M1**

(f) distance in the third segment = |(-5)-15| = 20 (9 to 14) **M1**

(f) 35 m cao, not the net displacement of -5 m **A1**

(f) Answer: 35 m

Question 11

distance in the acceleration phase = 1/2 x 4 x 8 = 16 **M1**

distance in the deceleration phase = 1/2 x 5 x 8 = 20 **M1**

set up 16 + 8T + 20 = 100 (or equivalent) **M1**

T = 8 cao **A1**

Answer: T = 8 s

© Revision Library | revisionlibrary.co.uk