3.5 Mechanics: Kinematics Depth: 30-minute Pack

EDEXCEL 9MA0 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A ball is thrown vertically upwards with speed 19.6 m/s. Using $g = 9.8$ m/s^2, find the time taken to reach its greatest height.

(Total for Question 1 is 1 mark)

---

2 Two runners pass the same point at the same instant, moving in the same direction along a straight track. Runner A moves at a constant speed of 5 m/s. The distance runner B has covered t seconds after passing the point is t^2 metres. Find the value of t (other than $t = 0$) at which B catches up with A.

(Total for Question 2 is 2 marks)

---

3 A cyclist passes point A with speed 4 m/s and constant acceleration 0.6 m/s^2. She passes point B, 10 m from A in the direction of motion, T seconds after passing A. Show that $3T^2 + 40T - 100 = 0$, and hence find the value of T, giving your answer to 3 significant figures.

(Total for Question 3 is 3 marks)

© Revision Library | revisionlibrary.co.uk

4 Amara throws a ball vertically upwards from a point 1.2 m above horizontal ground with speed 14 m/s. Model the ball as a particle moving freely under gravity, and use $g = 9.8$ m/s^2.

(a) Find the greatest height above the ground reached by the ball. **(3)**

(b) Find the time taken for the ball to hit the ground, giving your answer to 3 significant figures. **(3)**

(Total for Question 4 is 6 marks)

---

5 A ball is projected from a point A, which is 6 m above horizontal ground, with speed 25 m/s at an angle of elevation α, where $\sin(\alpha) = 7/25$. The ball moves freely under gravity until it hits the ground at point B. Use $g = 9.8$ m/s^2.

(a) Show that the initial horizontal and vertical components of velocity are 24 m/s and 7 m/s respectively. **(2)**

(b) Find the greatest height above the ground reached by the ball. **(3)**

(c) Show that the time taken for the ball to reach the ground satisfies $4.9t^2 - 7t - 6 = 0$, and hence find this time, giving your answer to 3 significant figures. **(5)**

(d) Find the horizontal distance from A to B, giving your answer to 3 significant figures. **(2)**

(Total for Question 5 is 12 marks)

© Revision Library | revisionlibrary.co.uk

Mark scheme · 3.5 Mechanics: Kinematics Depth: 30-minute Pack

Question 1

2 cao	**B1**

Answer: 2 s

Question 2

set the two distances equal: $t^2 = 5t$	**M1**
$t = 5$ cao (rejecting $t=0$)	**A1**

Answer: t = 5 s

Question 3

use $s = ut + 1/2\ a\ t^2$ with $u=4$, $a=0.6$, $s=10$ to form $10 = 4T + 0.3T^2$, then multiply by 10 to give the printed equation	**M1**
apply the quadratic formula to $3T^2 + 40T - 100 = 0$ and reject the negative root	**M1**
awrt 2.15 s	**A1**

Answer: T = 2.15 s (3 s.f.)

Question 4

(a) uses $v^2 = u^2 - 2gh$ with $v = 0$, $u = 14$, $g = 9.8$	**M1**
(a) height above point of projection = 10 (m)	**A1**
(a) adds 1.2 m: greatest height above ground = 11.2 (m) cao	**A1**

(a) Answer: 11.2 m

(b) uses $s = ut - 0.5gt^2$ with displacement -1.2 m from the point of projection (or equivalent, measuring from the ground)	**M1**
(b) correct quadratic $4.9t^2 - 14t - 1.2 = 0$ (oe)	**A1**
(b) t = awrt 2.94 (s), rejecting the negative root	**A1**

(b) Answer: t = 2.94 s (3sf)

Question 5

(a) uses $\sin(\alpha) = 7/25$ to identify $\cos(\alpha) = 24/25$ (7-24-25 triangle), and finds horizontal component $25 * 24/25 = 24$ cso	**B1**
(a) finds vertical component $25 * 7/25 = 7$ cso	**B1**

(a) Answer: 24 m/s and 7 m/s (shown)

(b) uses $v^2 = u^2 - 2gh$ vertically with $v = 0$, $u = 7$, to find height above A	**M1**
(b) height above A = 2.5 (m)	**A1**
(b) adds 6 m: greatest height above ground = 8.5 (m) cao	**A1**

(b) Answer: 8.5 m

(c) sets up the vertical displacement from A to the ground (6 m below A) as $7t - 4.9t^2 = -6$	**M1**
(c) rearranges to $4.9t^2 - 7t - 6 = 0$ cso	**A1**
(c) uses the quadratic formula on $4.9t^2 - 7t - 6 = 0$	**dM1**
(c) $t = (7 + \sqrt{166.6})/9.8$ evaluated correctly	**A1**
(c) t = awrt 2.03 (s), rejecting the negative root	**A1**

(c) Answer: $4.9t^2 - 7t - 6 = 0$ (shown); t = 2.03 s (3sf)

(d) horizontal distance = 24 * their t	**M1**
(d) awrt 48.8 (m) cao	**A1**

(d) Answer: 48.8 m (3sf)

© Revision Library | revisionlibrary.co.uk