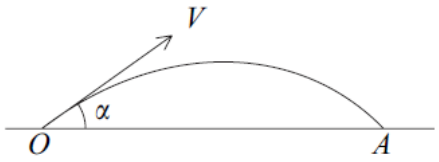
Projectiles Questions

5 A golf ball is projected from a point O with initial velocity V at an angle α to the horizontal. The ball first hits the ground at a point A which is at the same horizontal level as O, as shown in the diagram.



It is given that $V\cos\alpha = 6u$ and $V\sin\alpha = 2.5u$.

(a) Show that the time taken for the ball to travel from O to A is $\frac{5u}{g}$. *(4 marks)*

(b) Find, in terms of g and u, the distance OA. *(2 marks)*

(c) Find V, in terms of u. *(2 marks)*

(d) State, in terms of u, the least speed of the ball during its flight from O to A. *(1 mark)*

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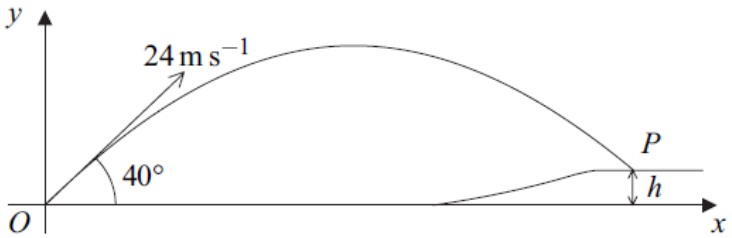
7 A golf ball is struck from a point O with velocity $24\,\text{m s}^{-1}$ at an angle of $40°$ to the horizontal. The ball first hits the ground at a point P, which is at a height h metres above the level of O.



The horizontal distance between O and P is 57 metres.

(a) Show that the time that the ball takes to travel from O to P is 3.10 seconds, correct to three significant figures. *(3 marks)*

(b) Find the value of h. *(3 marks)*

(c) (i) Find the speed with which the ball hits the ground at P. *(5 marks)*

(ii) Find the angle between the direction of motion and the horizontal as the ball hits the ground at P. *(2 marks)*

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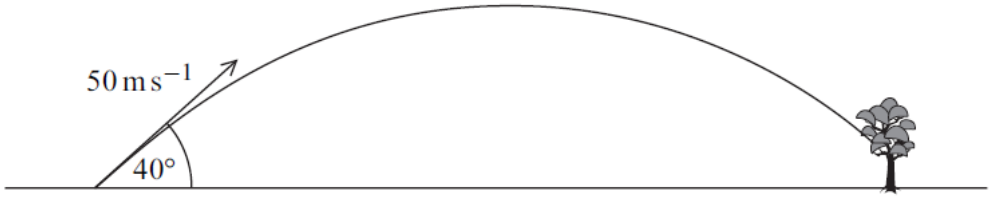
7 A golf ball is struck from a point on horizontal ground so that it has an initial velocity of $50\,\text{m}\,\text{s}^{-1}$ at an angle of 40° above the horizontal.

Assume that the golf ball is a particle and its weight is the only force that acts on it once it is moving.

(a) Find the maximum height of the golf ball. *(4 marks)*

(b) After it has reached its maximum height, the golf ball descends but hits a tree at a point which is at a height of 6 metres above ground level.



Find the time that it takes for the ball to travel from the point where it was struck to the tree. *(6 marks)*

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7 An arrow is fired from a point A with a velocity of $25\,\text{m}\,\text{s}^{-1}$, at an angle of 40° above the horizontal. The arrow hits a target at the point B which is at the same level as the point A, as shown in the diagram.

(a) State **two** assumptions that you should make in order to model the motion of the arrow. *(2 marks)*

(b) Show that the time that it takes for the arrow to travel from A to B is 3.28 seconds, correct to three significant figures. *(4 marks)*

(c) Find the distance between the points A and B. *(2 marks)*

(d) State the magnitude and direction of the velocity of the arrow when it hits the target. *(2 marks)*

(e) Find the minimum speed of the arrow during its flight. *(2 marks)*

Projectiles Answers

5(a)	$s = ut + \frac{1}{2}at^2$			
	$0 = 2\frac{1}{2}ut - \frac{1}{2}gt^2$	M1 A1		full method required for time (equation of motion, or standard result)
	$0 = t\left(2\frac{1}{2}u - \frac{1}{2}gt\right)$	m1		
	$t = \frac{5u}{g}$	A1	4	(if $g = 9.8$ used, lose last A1)
(b)	$OA = 6u \times \frac{5u}{g}$	M1		
	$= \frac{30u^2}{g}$	A1	2	cao
(c)	$\text{speed}^2 = (6u)^2 + \left(2\frac{1}{2}u\right)^2$	M1		
	$\text{speed} = 6\frac{1}{2}u$	A1	2	cao
(d)	Least speed, at top, $= 6u$	B1	1	
	Total		**9**	

7(a)	$57 = 24\cos 40° \times t$	M1 A1		Component attempted and acceleration $= 0$ All correct
	$t = 3.10$ sec	A1	3	CAO
(b)	$h = 24\sin 40° \times 3.1 - \frac{1}{2} \times 9.8 \times 3.1^2$	M1 A1		Component attempted & acceleration = 9.8 All correct
	$h = 0.734$ m	A1F	3	FT one slip e.g. +9.8 used Accept 2 s.f. answer, AWRT $0.71 - 0.74$
(c)(i)	horizontal, $u = 24\cos 40° = 18.39$ ms^{-1}	B1		Seen anywhere in (c) accept 18.4
	vertical, $v = 24\sin 40° - 9.8 \times 3.1$	M1		Component attempted & acceleration = 9.8
	$v = -14.95$ ms^{-1}	A1		(Accept -15.0)
	$V = \sqrt{(18.39)^2 + (-14.95)^2}$	M1		Use of candidate's u and new v (when $t = 3.1$)
	$V = 23.7$ ms^{-1}	A1F	5	FT use of candidate's u and v and new v when $t = 3.1$
(ii)	$\tan\theta = \frac{14.95}{18.39}$	M1		Use of candidate's u and v Accept inverted ratio
	$\theta = 39.1°$ or $39.2°$ Also $140.8°$ or $140.9°$ } accept ±	A1F	2	FT use of candidates u and v and V
	Total		**13**	

7(a)	$0^2 = (50\sin 40°)^2 + 2\times(-9.8)h$	M1A1		Equation for h with $v = 0$ and a component of velocity. Correct equation
	$h = \dfrac{(50\sin 40°)^2}{2\times 9.8} = 52.7$	dM1 A1		Solving for h Correct h
	Alt			
	$0 = 50\sin 40° - 9.8t$	(M1)		Equation for t with $v = 0$ and a component of velocity
	$t = \dfrac{50\sin 40°}{9.8} = 3.280$	(A1)		Correct t
	$h = 50\sin 40°\times 3.280 - \dfrac{1}{2}\times 9.8\times 3.280^2$	(dM1)		Expression for h with a component of velocity
	$= 52.7$ ALLOW 52.6	(A1)	4	Correct h
(b)	$6 = 50\sin 40°t - 4.9t^2$	M1A1		Forming a quadratic in t. Correct terms with any signs
	$0 = 4.9t^2 - 50\sin 40°t + 6$	A1		Correct equation
	$t = \dfrac{50\sin 40° \pm \sqrt{(50\sin 40°)^2 - 4\times 4.9\times 6}}{2\times 4.9}$	dM1		Solving quadratic
	$= 0.192$ or 6.37 $t = 6.37$	A2	6	Correct solution selected
	Alt			
	$46.7 = 4.9t_1^2$	(M1) (dM1)		Finding two times Equation for time to go down
	$t_1 = 3.087$	(A1)		Correct time
	$t_2 = 3.280$	(A1)		Time to go up
	$t = 3.087 + 3.280 = 6.37$	(A2)		Correct total
	Total		**10**	

7(a)	A particle or no spin No air resistance or no wind or only gravity acting	B1 B1	2	First assumption Second assumption If more than 2 assumptions given, subtract one mark for each incorrect additional assumption
(b)	$0 = 25\sin 40°t - 4.9t^2$ $0 = t(25\sin 40° - 4.9t)$ $t = 0$ or $t = \dfrac{25\sin 40°}{4.9}$ Time of flight = 3.28 s	M1 A1 dM1 A1	4	Equation for time of flight Correct equation Solving for t AG Correct final answer from correct working (Verification method M1A1M1A0)
(c)	$s = 3.28 \times 25\cos 40° = 62.8$ m	M1 A1	2	Finding range Correct range
(d)	25 ms^{-1} at 40° **below** the horizontal	B1 B1	2	Speed Direction
(e)	$v_{min} = 25\cos 40° = 19.2$ ms^{-1} **OR** $v_{min} = \dfrac{62.807}{3.2795} = 19.2$ ms^{-1}	M1 A1	2	Horizontal component of velocity Correct speed Accept 19.1 ms^{-1}
	Total		**12**	