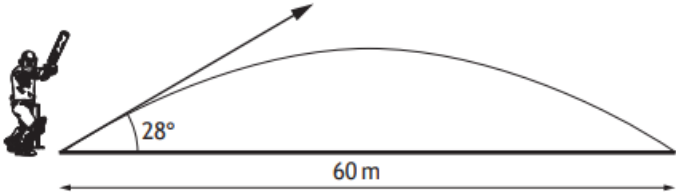| Y	Q	Projectiles
2022	3	A ball is kicked from horizontal ground with a speed of 25 m s^{-1} at an angle of 30° to the horizontal. (a) Calculate the maximum height of the ball. **2** As the ball falls it is caught at a height of 1 metre from the ground. (b) Calculate the total horizontal displacement of the ball during its motion. **3**

2019	15	A ball is kicked from floor level at an angle of θ with initial speed u m s^{-1} in a room of height 3 metres.
		
		(a) Show that, if the ball does not hit the ceiling, $\sin\theta < \dfrac{\sqrt{6g}}{u}$. **3**
		
		(b) The ball just touches the smooth ceiling at the highest point of its trajectory.
		
		  (i) Show that the range of the ball is $12\sqrt{\dfrac{u^2-6g}{6g}}$ metres. **5**
		
		  (ii) State the constraint that must be placed on the initial speed of the ball in this case. **1**

2018	9	A projectile is launched with speed v m s^{-1}, at an angle θ to the horizontal.
		
		(a) Show that the horizontal range R of the projectile is given in metres by
		
		$R = \dfrac{v^2 \sin 2\theta}{g}$. **4**
		
		(b) A tennis training device fires balls at the same speed each time, but the angle of projection can vary.
		
		A ball is fired at 30° to the horizontal and has a range of R metres.
		
		Another ball is fired at 35° to the horizontal and has a range of $(R+5)$ metres.
		
		  (i) Calculate the initial speed of the balls. **3**
		
		  (ii) On a particular day, the tennis balls are assisted by a horizontal tailwind of 7 m s^{-1}. Find the new range of a ball fired at 35° to the horizontal. **3**

2017	7	A cricket batsman hits a ball from ground level. The ball lands on the boundary which is 60 metres away. If the angle of flight to the horizontal ground is 28° at the instant the ball leaves the bat, calculate the initial speed of the ball. **5**

2016	16	A ball is projected from an origin on horizontal ground with speed $V\,\mathrm{m\,s^{-1}}$ at an angle of elevation of θ and moves freely under gravity. It passes through a point which is x metres horizontally from the origin at a height y metres above the ground.	
		(a) Show that the trajectory of the particle has equation	
		$$y = x\tan\theta - \frac{gx^2}{2V^2}\left(1+\tan^2\theta\right).$$	
		(Note that $\sec^2\theta = 1+\tan^2\theta$)	3
		(b) The ball is at a vertical height of h metres when it has travelled $4h$ metres horizontally.	
		It is again at a height of h metres when it has travelled a further h metres horizontally.	
		Determine the angle of projection θ.	5
2016 Spec	15	A golfer hits a ball from the point O with velocity $(Pi+Qj)\,\mathrm{m\,s^{-1}}$. The ball first hits the ground a distance of 50 metres from O in the horizontal plane.	
		(a) Show that $PQ=25g$.	4
		(b) Given that the ball passes through $45i+1\cdot6j$	
		(i) Calculate P.	4
		(ii) Calculate the initial angle of projection to the horizontal.	2