Old Exam Questions – Old Course
Projectiles

(M2 Summer 2006)

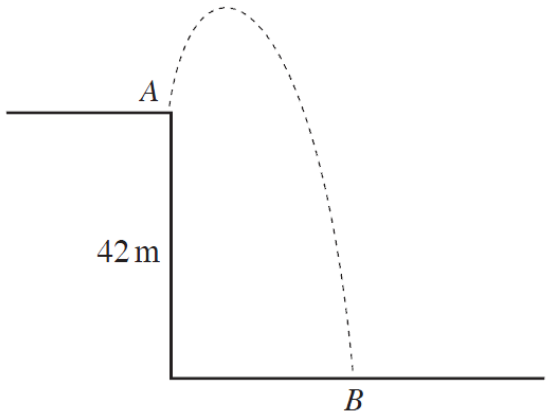
5. A stone is projected in a direction which makes an angle of 45° above the horizontal. It strikes a small target whose horizontal and vertical distances from the point of projection are 120 m and 41·6 m respectively. The target is above the level of the point of projection.

(a) Find the speed of projection and show that the time taken for the stone to reach the target is 4 s. [8]

(b) Determine, correct to two decimal places, the speed and direction of motion of the stone as it hits the target. [7]

(M2 Summer 2007)

4. A stone is projected from point A on the top of a vertical cliff and it hits the sea at point B. The height of A above sea level is 42 m.



The horizontal and vertical components of the stone's initial velocity are $4{\cdot}5\ \text{ms}^{-1}$ and $22{\cdot}4\ \text{ms}^{-1}$ respectively.

(a) Find the speed of the stone 2 s after projection. [5]

(b) Calculate the time of flight of the stone. [4]

(M2 Summer 2008)

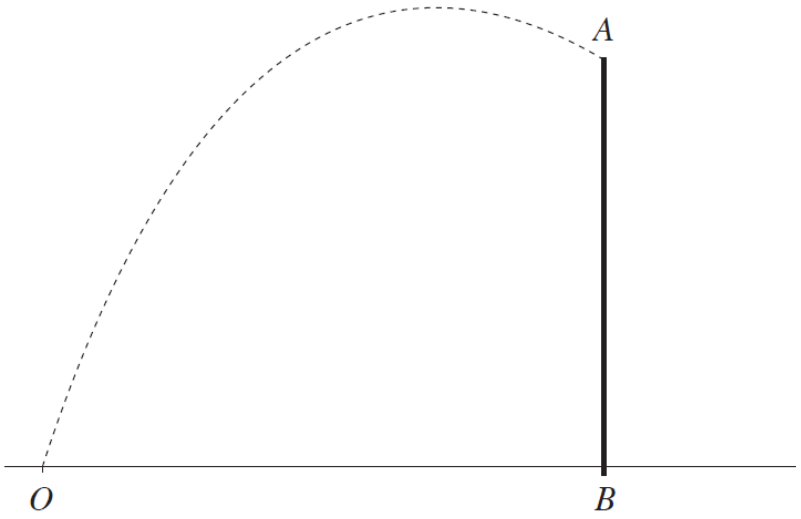
5. A particle is projected from point A on the horizontal ground such that its initial horizontal velocity is $12\ \text{ms}^{-1}$ and its initial vertical velocity is $14\ \text{ms}^{-1}$. After it reaches its highest point and it is on its way down, it just clears a wall, which is 8·4 m high.

(a) Find the horizontal distance of the wall from the point A. [6]

(b) Find the speed and direction of motion of the particle as it clears the wall. [7]

(M2 Summer 2009)

5. The diagram shows a vertical wall AB and a point O on the same horizontal level as B where $OB = 25{\cdot}2$ m. At time $t = 0$, a ball is projected from O with speed $17{\cdot}5$ ms^{-1} in a direction inclined at an angle α above the horizontal, where $\tan\alpha = \frac{4}{3}$. The ball just clears the top of the wall at A.



(a) Find the time at which the ball passes over the wall. [3]

(b) Calculate the height of the wall AB. [4]

(c) Find the time when the ball reaches its greatest height. [3]

(M2 Summer 2010)

5. The point A is at the top of a vertical cliff $39{\cdot}2$ m above sea level. A pebble is projected from point A with speed V ms^{-1} at an angle of 30° above the horizontal. The greatest height reached by the pebble is $4{\cdot}9$ m above A.

(a) Show that $V = 19{\cdot}6$. [4]

(b) Calculate the time taken for the pebble to reach the surface of the sea. [4]

(c) Find, correct to 3 significant figures, the speed of the pebble 3 s after projection. [5]

(M2 Summer 2011)

6. A stone is thrown from the top of a vertical cliff, 100 m above sea level. The initial velocity of the stone is $6{\cdot}5$ ms^{-1} at an angle α above the horizontal, where $\tan\alpha = \frac{5}{12}$.

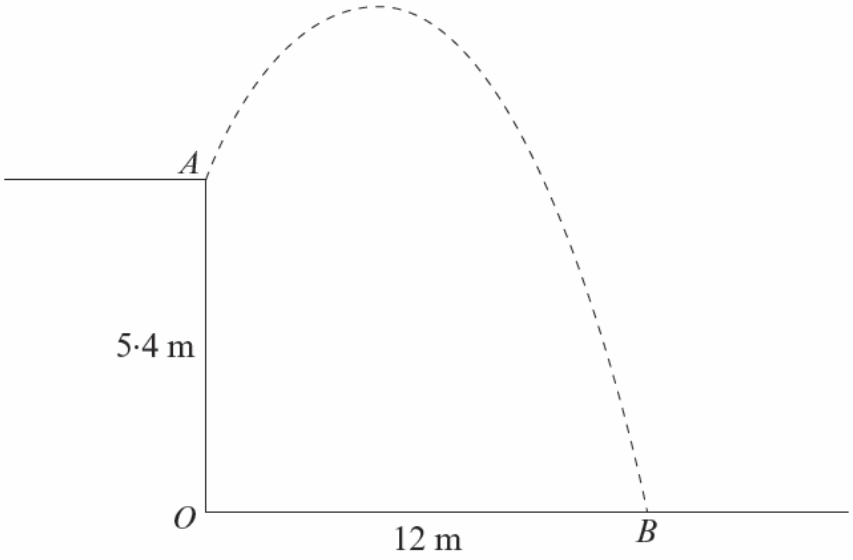
(a) Find the time taken for the stone to reach the sea. Give your answer correct to two decimal places. [5]

(b) Calculate the horizontal distance from the bottom of the cliff to the point where the stone hits the sea. [2]

(c) Calculate the magnitude and direction of the velocity with which the stone hits the sea. [7]

(M2 Summer 2012)

6. A pebble is projected from a point A which is 5·4 m vertically above a point O on horizontal ground.



The initial velocity of the pebble is V ms^{-1} at an angle α above the horizontal, where $\tan\alpha = \frac{3}{4}$. The pebble hits the ground at the point B which is at a distance of 12 m from O.

The time of flight of the pebble is T s.

(a) Write down the horizontal component and the vertical component of the initial velocity of the pebble in terms of V. [2]

(b) Show that $VT = 15$. [2]

(c) Find the value of T and hence find the value of V. [4]

(d) Determine the speed of the pebble as it hits the ground at B. [5]

(M2 Summer 2013)

3. A person throws a ball from a point A to hit a vertical pole, which is placed at a horizontal distance of 9 m from A. The point A is 1 m above the horizontal ground. The ball is projected with initial speed 15 ms^{-1} at an angle α above the horizontal, where $\tan\alpha = \frac{3}{4}$.

(a) Given that the ball hits the pole at a point B,

(i) find the time taken for the ball to reach B,

(ii) determine the height of B above the ground. [7]

(b) Given that the ball misses the pole and hits the ground, calculate the speed with which it hits the ground. [5]

(M2 Summer 2014)

5. A player kicks a ball from a point *A* on horizontal ground so that 2·5 seconds later the ball just clears a bar at a point *B*. The point *B* is 3 m above the ground. The horizontal distance of *B* from *A* is 42 m.

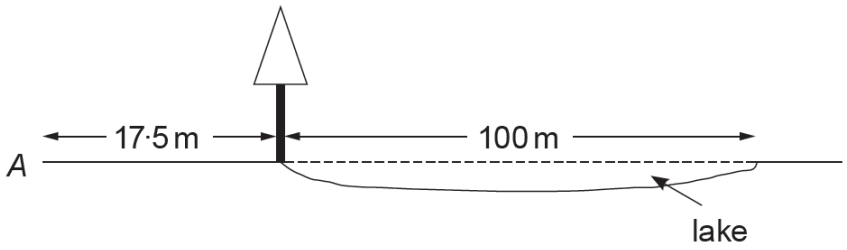
(a) Calculate the horizontal and vertical components of the initial velocity of the ball. [4]

(b) Find the magnitude of the velocity of the ball and the angle that the direction of the velocity makes with the horizontal as it passes the point *B*. [6]

(c) Determine the horizontal distance from *B* to the point where the ball first hits the ground again. [3]

(M2 Summer 2015)

6. A golfer hits a ball from a point *A* with initial velocity of 35 ms^{-1} at an angle α above the horizontal where sin α = 0·8. The ball passes over a tree which is growing in front of a lake. The lake is 100 m wide, as shown in the diagram. The tree is at a horizontal distance of 17·5 m from *A*.



(a) Determine whether or not the golf ball will fall into the lake. [6]

(b) Find the magnitude and direction of the velocity of the ball as it passes over the tree. [7]

(M2 Summer 2016)

2. A particle is projected from horizontal ground with speed 24·5 ms^{-1} in a direction inclined at an angle of 30° above the horizontal.

(a) Calculate the horizontal range of the particle. [6]

(b) Determine the maximum height reached by the particle. [3]

(c) Write down the speed and the direction of motion of the particle as it hits the ground. [1]

(M2 Summer 2017)

4. *A* and *B* are points a distance 18 m apart on horizontal ground. An object *P* is projected from *A* towards *B* with velocity 15 ms^{-1} at an angle of 60° to the horizontal. Simultaneously, another object *Q* is projected from *B* towards *A* with velocity v ms^{-1} at an angle of 30° to the horizontal. The objects collide.

(a) Find the value of v. [5]

(b) Show that the time from projection to collision is 0·6 seconds. [3]

(c) Determine the speed of the object *P* just before collision. [4]

(M2 Summer 2018)

6. A ball is projected from a point *A* on horizontal ground with initial velocity V ms^{-1} at an angle θ above the horizontal. The ball just clears a vertical wall 3 m high which is at a horizontal distance of 6 m from *A*.

(a) Show that V and θ satisfy the equation

$$3 = 6\tan\theta - \frac{18g}{V^2\cos^2\theta},$$

where g is the acceleration due to gravity. [3]

The ball also just clears the top of a building 10 m high which is at a horizontal distance of 24 m from *A*.

(b) Find the value of θ and the value of V. [6]