# Edexcel A level Maths Projectiles

## Topic assessment

**Take $g$ = 9.8 ms$^{-2}$ unless otherwise instructed.**

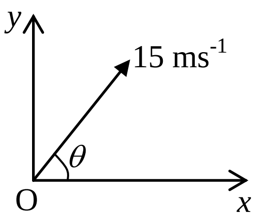
1. A sprinkler on horizontal ground is projecting drops of water from ground level in all directions. The water droplets all have an initial speed of 15 ms$^{-1}$.

   **Take $g$ = 10 ms$^{-2}$ in this question**. Air resistance should be neglected.

   (i) Calculate the height reached by a water droplet projected vertically upwards.

   What can you say about the height reached by water droplets projected at other angles? Explain your answer briefly. [4]

   The diagram below shows $x$- and $y$-axes drawn through O, the point of projection. The units of the axes are metres.




   One water droplet is projected at time $t$ = 0 at an angle $\theta$ to the horizontal, where $\cos\theta = 0.6$ and $\sin\theta = 0.8$.

   (ii) Show that, after time $t$ seconds, the position of the water droplet is given by

$$x = 9t, \qquad y = 12t - 5t^2. \qquad [3]$$

   (iii) Show that the equation of the trajectory of this water droplet is

$$y = \tfrac{4}{3}x - \tfrac{5}{81}x^2. \qquad [3]$$

   (iv) Hence calculate how far from the sprinkler this water droplet lands. [3]

   Another water droplet on the same trajectory hits a bird at a horizontal distance of 18 m from O.

   (v) How far above the ground does the water droplet hit the bird? [2]

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2. A golf ball is hit over horizontal ground from a point O on the ground. The velocity of projection is 30 ms$^{-1}$ at 40° to the horizontal. The effects of air resistance should be neglected.

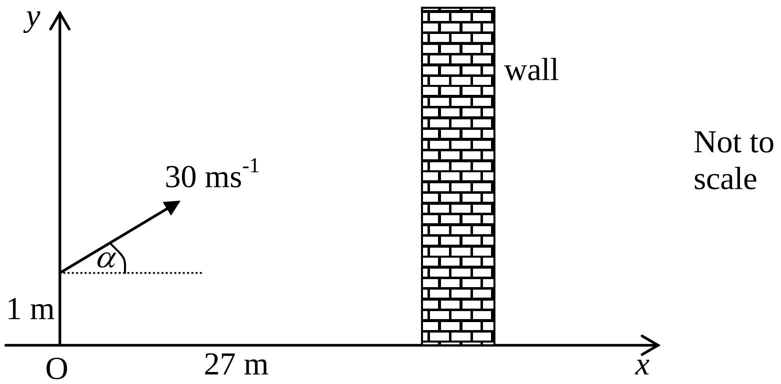
   (i) The ball is $y$ m above the ground $t$ seconds after projection. Write down an expression for $y$ in terms of $t$ and hence determine the time at which the ball first hits the ground. [5]

   The ball passes directly over a tree which is at a horizontal distance of 34 m from O.

   (ii) Determine the speed of the ball as it passes over the tree. Calculate also the angle between the direction of motion of the ball and the horizontal at that time, making it clear whether the ball is rising or falling. [10]

3. **In this question you should take $g$ = 10 ms$^{-2}$. The effects of air resistance should be neglected**.

   A small stone is fired from a catapult 1 m above horizontal ground at a speed of 30 ms$^{-1}$. The angle of projection with the horizontal is $\alpha$, where $\cos\alpha = 0.6$ and $\sin\alpha = 0.8$. The stone hits a vertical wall that is a horizontal distance of 27 m from the point of projection. This information is shown in the diagram below together with $x$- and $y$-axes and the origin O on the ground; the units of the axes are metres.




   (i) Show that, after $t$ seconds, the horizontal displacement of the stone from O, $x$ m, and the vertical displacement, $y$ m, are given by

   $$x = 18t \qquad \text{and} \qquad y = 1 + 24t - 5t^2 .$$ [5]

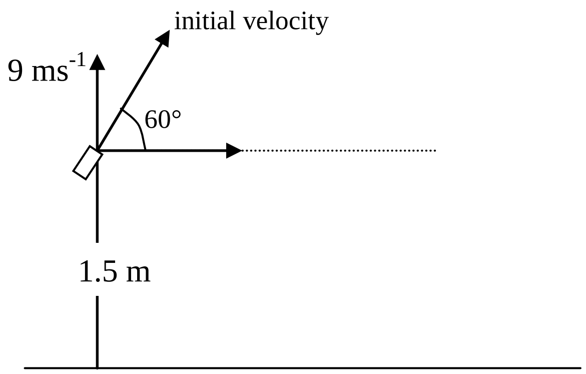
   (ii) What is the value of $t$ when the stone hits the wall?
   How high is the stone above the ground when it hits the wall? [3]

   (iii) Show that the stone is rising when it hits the wall. [2]

   (iv) Find the horizontal displacement of the stone when it is at a height of 17 m above the ground. [5]

4. Air resistance should be neglected in this question.

   A bottle of champagne is held with its cork 1.5 m above a level floor. The cork leaves the bottle at 60° to the horizontal. The cork has a *vertical* component of velocity of 9 $ms^{-1}$, as shown in the diagram.




   (i) Show that the initial horizontal component of velocity is 5.20 $ms^{-1}$, correct to three significant figures. [2]

   (ii) Find the maximum height above the floor reached by the cork. [3]

   (iii) Write down an expression in terms of $t$ for the height of the cork above the floor $t$ seconds after projection. [2]

   After projection, the cork is in the air for $T$ seconds before it hits the floor.

   (iv) Show that $T$ satisfies the equation $49T^2 - 90T - 15 = 0$.

   Hence show that the cork is in the air for 1.99 s, correct to three significant figures.

   Calculate the horizontal distance travelled by the cork before it hits the floor. [5]

   (v) Calculate the speed with which the cork hits the floor. [3]

**Total 60**