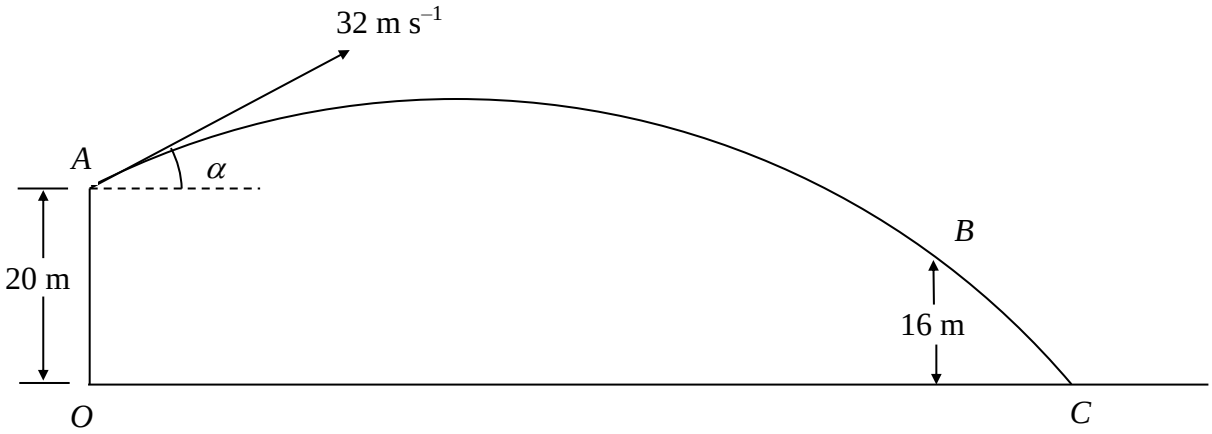
Projectiles - Edexcel Past Exam Questions

1. **Figure 4**



A particle P is projected from a point A with speed 32 m s^{-1} at an angle of elevation α, where $\sin\alpha = \frac{3}{5}$. The point O is on horizontal ground, with O vertically below A and OA = 20 m. The particle P moves freely under gravity and passes through a point B, which is 16 m above ground, before reaching the ground at the point C, as shown in Figure 4.

Calculate

(a) the time of the flight from A to C, **(5)**

(b) the distance OC, **(3)**

(c) the speed of P at B, **(4)**

(d) the angle that the velocity of P at B makes with the horizontal. **(3)**

Jan 05 Q7

2. A darts player throws darts at a dart board which hangs vertically. The motion of a dart is modelled as that of a particle moving freely under gravity. The darts move in a vertical plane which is perpendicular to the plane of the dart board. A dart is thrown horizontally with speed 12.6 m s^{-1}. It hits the board at a point which is 10 cm below the level from which it was thrown.

(*a*) Find the horizontal distance from the point where the dart was thrown to the dart board. **(4)**

The darts player moves his position. He now throws a dart from a point which is at a horizontal distance of 2.5 m from the board. He throws the dart at an angle of elevation α to the horizontal, where $\tan \alpha = \frac{7}{24}$. This dart hits the board at a point which is at the same level as the point from which it was thrown.

(*b*) Find the speed with which the dart is thrown. **(6)**

June 05 Q4

3.

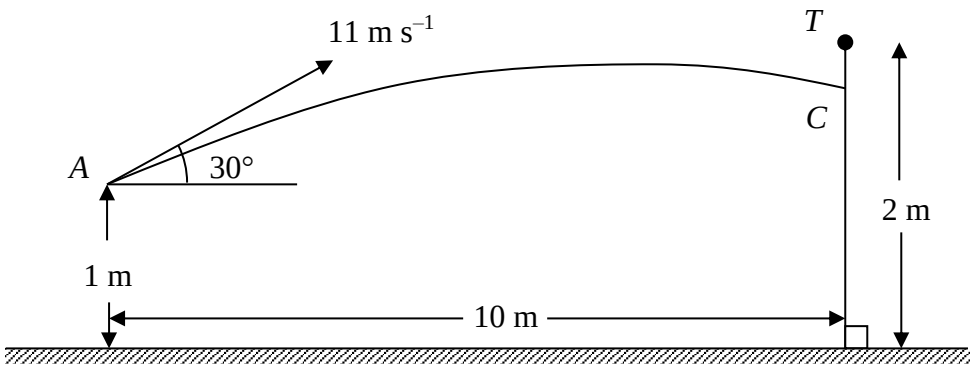


Figure 3

The object of a game is to throw a ball *B* from a point *A* to hit a target *T* which is placed at the top of a vertical pole, as shown in Figure 3. The point *A* is 1 m above horizontal ground and the height of the pole is 2 m. The pole is at a horizontal distance of 10 m from *A*. The ball *B* is projected from *A* with a speed of 11 m s^{-1} at an angle of elevation of 30°. The ball hits the pole at the point *C*. The ball *B* and the target *T* are modelled as particles.

(*a*) Calculate, to 2 decimal places, the time taken for *B* to move from *A* to *C*. **(3)**

(*b*) Show that *C* is approximately 0.63 m below *T*. **(4)**

The ball is thrown again from *A*. The speed of projection of *B* is increased to *V* m s^{-1}, the angle of elevation remaining 30°. This time *B* hits *T*.

(*c*) Calculate the value of *V*. **(6)**

(*d*) Explain why, in practice, a range of values of *V* would result in *B* hitting the target. **(1)**

Jan 06 Q7

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4. A vertical cliff is 73.5 m high. Two stones A and B are projected simultaneously. Stone A is projected horizontally from the top of the cliff with speed 28 m s^{-1}. Stone B is projected from the bottom of the cliff with speed 35 m s^{-1} at an angle α above the horizontal. The stones move freely under gravity in the same vertical plane and collide in mid-air. By considering the horizontal motion of each stone,

(a) prove that $\cos \alpha = \frac{4}{5}$. **(4)**

(b) Find the time which elapses between the instant when the stones are projected and the instant when they collide. **(4)**

June 06 Q5

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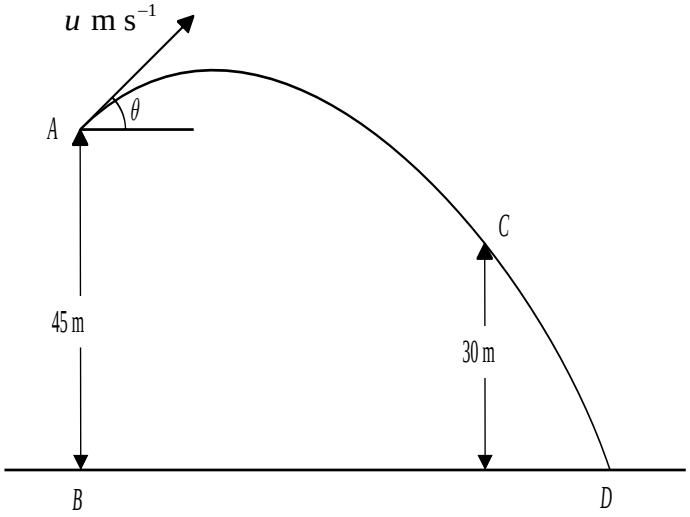
5. **Figure 3**



A particle P is projected from a point A with speed u m s^{-1} at an angle of elevation θ, where $\cos \theta = \frac{4}{5}$. The point B, on horizontal ground, is vertically below A and AB = 45 m. After projection, P moves freely under gravity passing through point C, 30 m above the ground, before striking the ground at the point D, as shown in Figure 3.

Given that P passes through C with speed 24.5 m s^{-1},

(a) using conservation of energy, or otherwise, show that u = 17.5, **(4)**

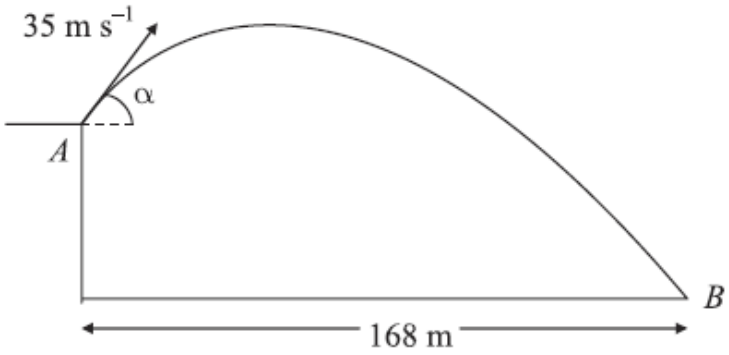
(b) find the size of the angle which the velocity of P makes with the horizontal as P passes through C, **(3)**

(c) find the distance BD. **(7)**

Jan 07 Q7

6.

Figure 4



A golf ball P is projected with speed 35 m s^{-1} from a point A on a cliff above horizontal ground. The angle of projection is α to the horizontal, where $\tan \alpha = \frac{4}{3}$. The ball moves freely under gravity and hits the ground at the point B, as shown in Figure 4.

(a) Find the greatest height of P above the level of A. **(3)**

The horizontal distance from A to B is 168 m.

(b) Find the height of A above the ground. **(6)**

(c) find the speed of P as it hits the ground at B. **(3)**

June 07 Q6

7.

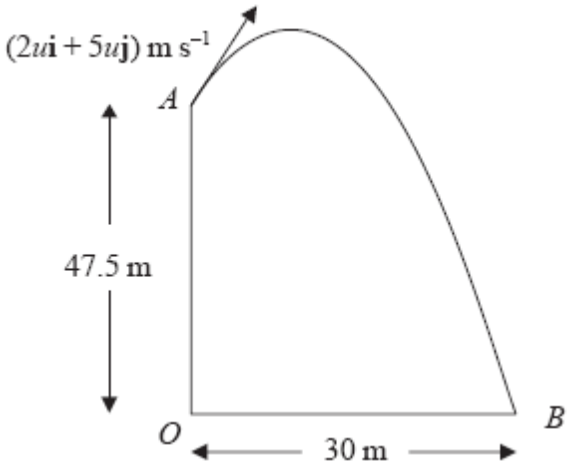


Figure 3

[*In this question, the unit vectors* **i** *and* **j** *are in a vertical plane,* **i** *being horizontal and* **j** *being vertical.*]

A particle P is projected from the point A which has position vector $47.5\mathbf{j}$ metres with respect to a fixed origin O. The velocity of projection of P is $(2u\mathbf{i} + 5u\mathbf{j})$ m s^{-1}. The particle moves freely under gravity passing through the point B with position vector $30\mathbf{i}$ metres, as shown in Figure 3.

(*a*) Show that the time taken for P to move from A to B is 5 s. **(6)**

(*b*) Find the value of u. **(2)**

(*c*) Find the speed of P at B. **(5)**

Jan 08 Q6

8.

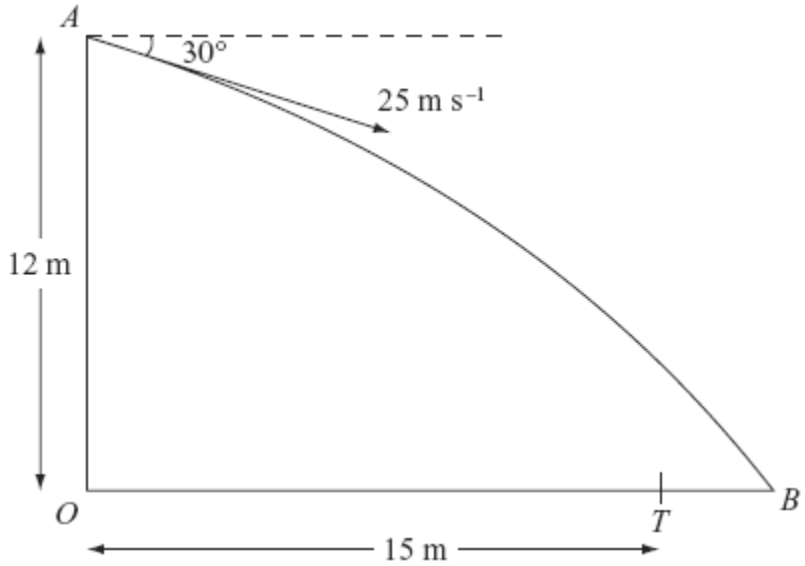


Figure 4

A ball is thrown from a point A at a target, which is on horizontal ground. The point A is 12 m above the point O on the ground. The ball is thrown from A with speed 25 m s^{-1} at an angle of 30° below the horizontal. The ball is modelled as a particle and the target as a point T. The distance OT is 15 m. The ball misses the target and hits the ground at the point B, where OTB is a straight line, as shown in Figure 4. Find

(a) the time taken by the ball to travel from A to B, **(5)**

(b) the distance TB. **(4)**

The point X is on the path of the ball vertically above T.

(c) Find the speed of the ball at X. **(5)**

June 08 Q7

9.

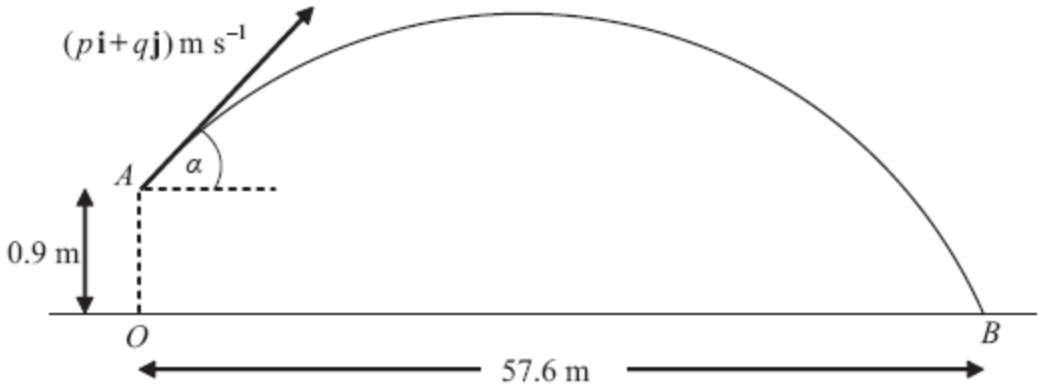


Figure 3

A cricket ball is hit from a point A with velocity of $(p\mathbf{i} + q\mathbf{j})$ m s^{-1}, at an angle α above the horizontal. The unit vectors **i** and **j** are respectively horizontal and vertically upwards. The point A is 0.9 m vertically above the point O, which is on horizontal ground.

The ball takes 3 seconds to travel from A to B, where B is on the ground and OB = 57.6 m, as shown in Figure 3. By modelling the motion of the cricket ball as that of a particle moving freely under gravity,

(*a*) find the value of p, **(2)**

(*b*) show that q = 14.4, **(3)**

(*c*) find the initial speed of the cricket ball, **(2)**

(*d*) find the exact value of tan α. **(1)**

(*e*) Find the length of time for which the cricket ball is at least 4 m above the ground. **(6)**

(*f*) State an additional physical factor which may be taken into account in a refinement of the above model to make it more realistic. **(1)**

Jan 09 Q6

10.

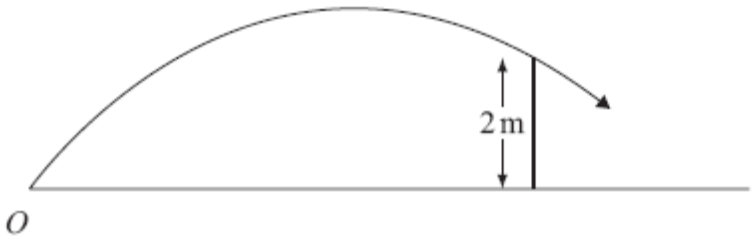


Figure 3

A child playing cricket on horizontal ground hits the ball towards a fence 10 m away. The ball moves in a vertical plane which is perpendicular to the fence. The ball just passes over the top of the fence, which is 2 m above the ground, as shown in Figure 3.

The ball is modelled as a particle projected with initial speed u m s^{-1} from point O on the ground at an angle α to the ground.

(a) By writing down expressions for the horizontal and vertical distances, from O of the ball t seconds after it was hit, show that

$$2 = 10 \tan \alpha - \frac{50g}{u^2 \cos^2 \alpha}.$$

(6)

Given that $\alpha = 45°$,

(b) find the speed of the ball as it passes over the fence. **(6)**

June 09 Q6

11. [*In this question* **i** *and* **j** *are unit vectors in a horizontal and upward vertical direction respectively*.]

A particle P is projected from a fixed point O on horizontal ground with velocity $u(\mathbf{i} + c\mathbf{j})$ m s^{-1}, where c and u are positive constants. The particle moves freely under gravity until it strikes the ground at A, where it immediately comes to rest. Relative to O, the position vector of a point on the path of P is $(x\mathbf{i} + y\mathbf{j})$ m.

(a) Show that

$$y = cx - \frac{4.9x^2}{u^2}.$$

(5)

Given that $u = 7$, $OA = R$ m and the maximum vertical height of P above the ground is H m,

(b) using the result in part (a), or otherwise, find, in terms of c,

(i) R

(ii) H. **(6)**

Given also that when P is at the point Q, the velocity of P is at right angles to its initial velocity,

(c) find, in terms of c, the value of x at Q. **(6)**

Jan 10 Q8

12.

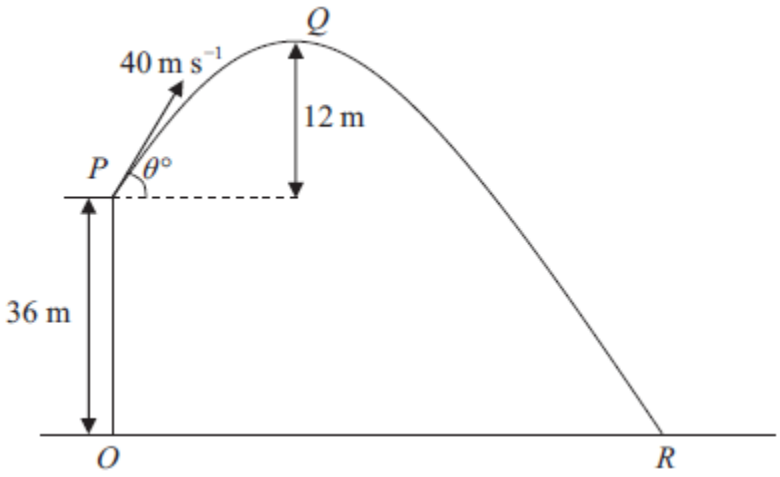


Figure 3

A ball is projected with speed 40 m s^{-1} from a point P on a cliff above horizontal ground. The point O on the ground is vertically below P and OP is 36 m. The ball is projected at an angle $\theta°$ to the horizontal. The point Q is the highest point of the path of the ball and is 12 m above the level of P. The ball moves freely under gravity and hits the ground at the point R, as shown in Figure 3. Find

(a) the value of θ, **(3)**

(b) the distance OR, **(6)**

(c) the speed of the ball as it hits the ground at R. **(3)**

June 10 Q7

13. [*In this question, the unit vectors* **i** *and* **j** *are in a vertical plane,* **i** *being horizontal and* **j** *being vertically upwards.*]

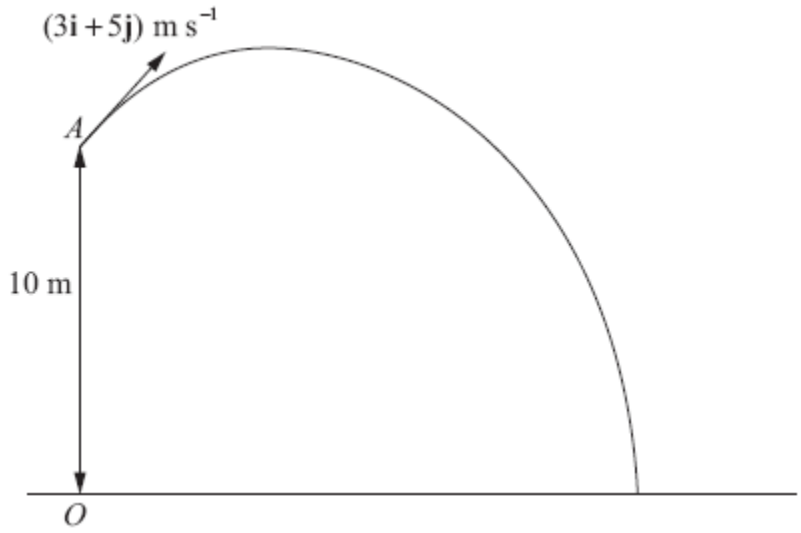


Figure 3

At time $t = 0$, a particle P is projected from the point A which has position vector $10\mathbf{j}$ metres with respect to a fixed origin O at ground level. The ground is horizontal. The velocity of projection of P is $(3\mathbf{i} + 5\mathbf{j})$ m s^{-1}, as shown in Figure 3. The particle moves freely under gravity and reaches the ground after T seconds.

(*a*) For $0 \leq t \leq T$, show that, with respect to O, the position vector, **r** metres, of P at time t seconds is given by

$$\mathbf{r} = 3t\mathbf{i} + (10 + 5t - 4.9t^2)\mathbf{j}$$ **(3)**

(*b*) Find the value of T. **(3)**

(*c*) Find the velocity of P at time t seconds $(0 \leq t \leq T)$. **(2)**

When P is at the point B, the direction of motion of P is 45° below the horizontal.

(*d*) Find the time taken for P to move from A to B. **(2)**

(*e*) Find the speed of P as it passes through B. **(2)**

Jan 11 Q6

14. A particle is projected from a point O with speed u at an angle of elevation α above the horizontal and moves freely under gravity. When the particle has moved a horizontal distance x, its height above O is y.

(a) Show that

$$y = x \tan \alpha - \frac{gx^2}{2u^2 \cos^2 \alpha}. \quad \textbf{(4)}$$

A girl throws a ball from a point A at the top of a cliff. The point A is 8 m above a horizontal beach. The ball is projected with speed 7 m s^{-1} at an angle of elevation of 45°. By modelling the ball as a particle moving freely under gravity,

(b) find the horizontal distance of the ball from A when the ball is 1 m above the beach. **(5)**

A boy is standing on the beach at the point B vertically below A. He starts to run in a straight line with speed v m s^{-1}, leaving B 0.4 seconds after the ball is thrown.

He catches the ball when it is 1 m above the beach.

(c) Find the value of v. **(4)**

June 11 Q8