Projectiles Exam Questions

Note These exam questions are given in reverse chronological order as they appear in exam papers; 2023 paper, Sample paper, 2022 (deferred), 2022, and so on back to 2015. Q3 (a) from 2005 is also included as an example of projectiles that bounce. Only questions from the old syllabus relevant to the new syllabus are included.

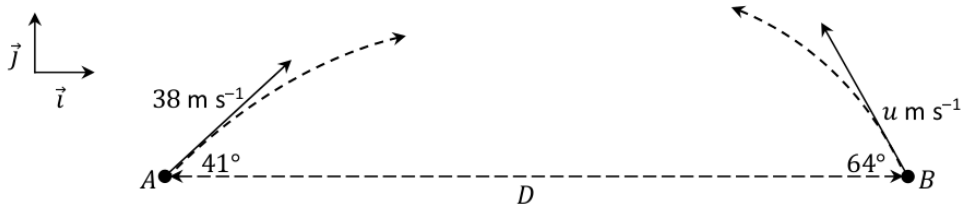
Question — 2023 Q8.

Question 8

Two balls, P and Q, are projected into the air from points A and B, which are a distance D apart along the horizontal $\vec{\imath}$ axis. The motion of the balls may be modelled as projectile motion in a vertical plane, ignoring the effects of air resistance.

P is projected from point A at time $t = 0$ s with initial velocity 38 m s^{-1} at 41° to AB.

Q is projected from point B at time $t = 1$ s with initial velocity u m s^{-1} at 64° to BA.



P and Q collide in mid-air when $t = 3$ s.

(i) Show that $u = 28$ m s^{-1} to the nearest whole number.

(ii) Calculate D.

(iii) In terms of $\vec{\imath}$ and $\vec{\jmath}$, calculate $\overrightarrow{v_P}$, the velocity of P, and $\overrightarrow{v_Q}$, the velocity of Q, when the balls collide, i.e. when $t = 3$ s.

(iv) Calculate the dot product of $\overrightarrow{v_P}$ and $\overrightarrow{v_Q}$ when $t = 3$ s.

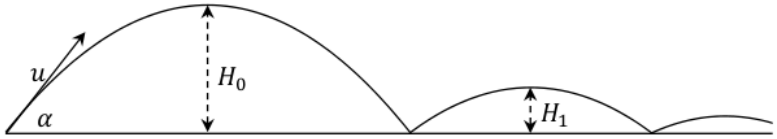
(v) Hence or otherwise calculate the acute angle between $\overrightarrow{v_P}$ and $\overrightarrow{v_Q}$ when $t = 3$ s.

Question — Sample Q4 (a).

Question 4

(a) A ball is projected from a point on horizontal ground, with initial speed u and at an angle α to the horizontal. The ball reaches a maximum height of H_0 above the horizontal.

Upon landing, the ball bounces with a maximum height of H_1.



The coefficient of restitution between the ball and the ground is e.

(i) Calculate $\frac{H_0}{H_1}$.

(ii) The ball continues bouncing. Find an expression (in terms of e and H_0) for H_5, the maximum height of the ball after it lands on the ground for the fifth time.

Question — 2022 (Deferred) Q3 (a).

(a) A particle is projected from a point on horizontal ground. The speed of projection is 14 m s^{-1} at an angle α to the horizontal.

Find the two values of α that will give a range of 10 m.

Question — 2022 Q3 (a).

(a) A particle is projected out to sea from a point *P* on a cliff to hit a target 60 m horizontally from *P* and 60 m vertically below *P*.

The velocity of projection is $14\sqrt{3}$ m s^{-1} at an angle α to the horizontal.

Find

(i) the two possible values of α

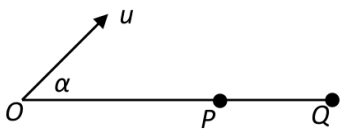
(ii) the times of flight.

Question — 2021 Q3 (a).

(a) A particle is projected from a point O with speed u m s^{-1} at an angle α to the horizontal.

(i) Show that the range of the particle is $\frac{u^2 \sin 2\alpha}{g}$,

and that the maximum range $|OQ|$ is $\frac{u^2}{g}$.



If the angle of projection is increased to 60° the particle strikes the horizontal plane at P.

(ii) Find the distance $|PQ|$ in terms of u.

Question — 2020 Q3 (a).

(a) A particle is projected from a point P with speed u m s^{-1} at an angle α to the horizontal.

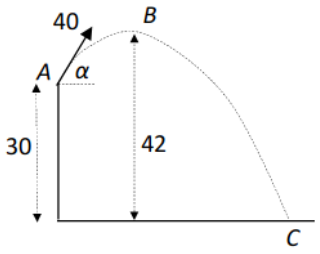
(i) Show that the range of the particle is $\frac{2u^2 \sin \alpha \cos \alpha}{g}$.

The particle is 24·5 m above the horizontal ground after 5 seconds and it strikes the ground 235·2 m from P.

(ii) Find the value of u.

Question — 2019 Q3 (a).

3. (a) A particle is projected with speed 40 m s^{-1} from a point A on the top of a vertical cliff of height 30 m.
The maximum height reached by the particle is 42 m above the horizontal ground, at point B.
It strikes the ground at C.



Find

(i) the value of α, the angle of projection

(ii) the horizontal range of the particle

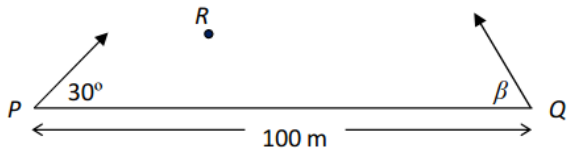
(iii) the speed of the particle as it hits the ground at C.

Question — 2018 Q3 (a).

3. (a) A particle is projected from a point P with speed 60 m s^{-1} at an angle of 30° to the horizontal. At the same time a second particle is projected from a point Q with speed 50 m s^{-1} at an angle β to the horizontal. P and Q are on the same horizontal level and are 100 m apart. The particles collide at R as shown in the diagram.

(i) Show that $\sin\beta = \frac{3}{5}$.

(ii) Find the distance $|PR|$.



Question — 2017 Q3 (a).

3. (a) A particle is projected with speed $\sqrt{\frac{9gh}{2}}$ from a point P on the top of a cliff of height h. It strikes the ground a horizontal distance $3h$ from P.

(i) Find the two possible angles of projection.

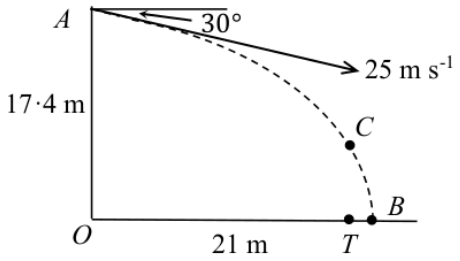
(ii) For each angle of projection find, in terms of h, the time it takes the particle to reach P.

Question — 2016 Q3 (a).

(a) A ball is thrown from a point A at a target T, which is on horizontal ground. The point A is 17·4 m vertically 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 distance OT is 21 m.
The ball misses the target and hits the ground at the point B, as shown in the diagram.
Find

(i) the time taken for the ball to travel from A to B

(ii) the distance TB.

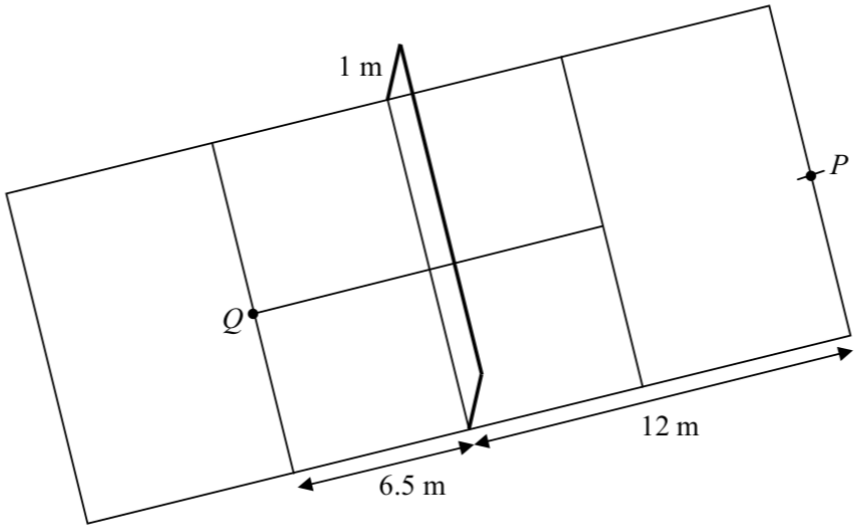


The point C is on the path of the ball vertically above T.

(iii) Find the speed of the ball at C.

Question — 2015 Q3 (a).

(a) A tennis player, standing at P, serves a tennis ball from a height of 3 m to strike the court at Q. The speed of serve is 50 m s^{-1} at an angle β to the horizontal.



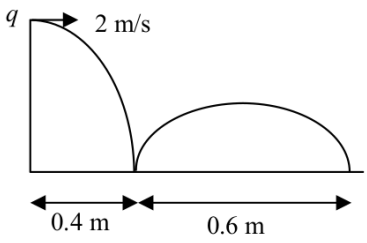
(i) Find the two possible values of $\tan\beta$.

(ii) For each value of $\tan\beta$ find the time, t, it takes the ball to reach Q.

(iii) If the tennis player chooses the smaller value of t, by what distance does the ball clear the net?

Question — 2005 Q3 (a).

(a) A ball is projected horizontally from a point q above a smooth horizontal plane with speed 2 m/s.
The ball first hits the plane at a point whose horizontal displacement from q is 0.4 m.
The ball next strikes the plane at a horizontal displacement of 1 m from q.
The coefficient of restitution between the ball and the plane is e.



Find the value of e.