



FM1 (Year 2) – Oblique Collisions Exam Questions (Edexcel)

Q1.

A small smooth ball of mass m is falling vertically when it strikes a fixed smooth plane which is inclined to the horizontal at an angle α , where $0^\circ < \alpha < 45^\circ$. Immediately before striking the plane the ball has speed u . Immediately after striking the plane the ball moves in a direction which makes an angle of 45° with the plane. The coefficient of restitution between the ball and the plane is e . Find, in terms of m , u and e , the magnitude of the impulse of the plane on the ball.

(11)

(Total 11 marks)

(Q06 6680/01/R, June 2014)

Q2.

A small ball is moving on a smooth horizontal plane when it collides obliquely with a smooth plane vertical wall. The coefficient of restitution between the ball and the wall is $\frac{1}{3}$. The speed of the ball immediately after the collision is half the speed of the ball immediately before the collision.

Find the angle through which the path of the ball is deflected by the collision.

(8)

(Total 8 marks)

(Q05 6680/01, June 2014)

Q3.

A smooth uniform sphere A , of mass $5m$ and radius r , is at rest on a smooth horizontal plane. A second smooth uniform sphere B , of mass $3m$ and radius r , is moving in a straight line on the plane with speed $u \text{ m s}^{-1}$ and strikes A . Immediately before the impact the direction of motion of B makes an angle of 60° with the line of centres of the spheres. The direction of motion of B is turned through an angle of 30° by the impact.

Find

(a) the speed of B immediately after the impact,

(3)

(b) the coefficient of restitution between the spheres.

(6)

(Total 9 marks)

(Q06 6680/01/R, June 2013)



Q4.

A smooth uniform sphere S , of mass m , is moving on a smooth horizontal plane when it collides obliquely with another smooth uniform sphere T , of the same radius as S but of mass $2m$, which is at rest on the plane. Immediately before the collision the velocity of S makes an angle a , where $\tan a = 0.75$, with the line joining the centres of the spheres.

Immediately after the collision the speed of T is V . The coefficient of restitution between the spheres is 0.75.

(a) Find, in terms of V , the **speed** of S

- (i) immediately before the collision,
- (ii) immediately after the collision.

(9)

(b) Find the angle through which the direction of motion of S is deflected as a result of the collision.

(4)

(Total 13 marks)
(Q04 6680/01, June 2012)

Q5.

A small ball is moving on a horizontal plane when it strikes a smooth vertical wall. The coefficient of restitution between the ball and the wall is e . Immediately before the impact the direction of motion of the ball makes an angle of 60° with the wall. Immediately after the impact the direction of motion of the ball makes an angle of 30° with the wall.

(a) Find the fraction of the kinetic energy of the ball which is lost in the impact.

(6)

(b) Find the value of e .

(4)

(Total 10 marks)
(Q05 6680/01, June 2007)

Q6.

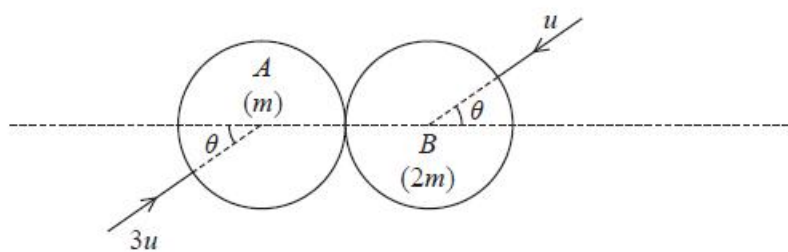


Figure 1

Two smooth uniform spheres A and B with equal radii have masses m and $2m$ respectively. The spheres are moving in opposite directions on a smooth horizontal surface and collide obliquely.

Immediately before the collision, A has speed $3u$ with its direction of motion at an angle θ to the line of centres, and B has speed u with its direction of motion at an angle θ to the line of centres, as shown in Figure 1. The coefficient of restitution between the

spheres is $\frac{1}{8}$.

Immediately after the collision, the speed of A is twice the speed of B . Find the size of the angle θ .

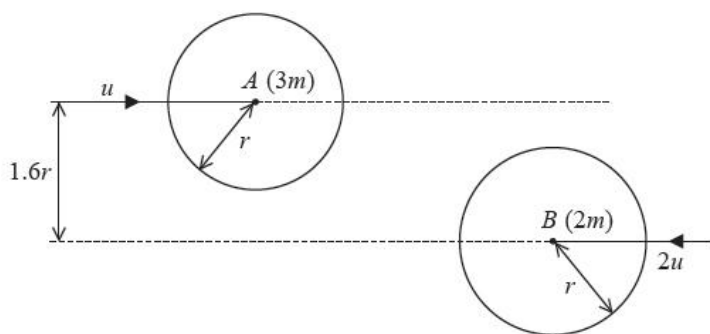
(12)

(Total for question = 12 marks)

(Q05 6680/01, June 2015)



Q7.



Two smooth uniform spheres A and B , of equal radius r , have masses $3m$ and $2m$ respectively. The spheres are moving on a smooth horizontal plane when they collide. Immediately before the collision they are moving with speeds u and $2u$ respectively. The centres of the spheres are moving towards each other along parallel paths at a distance $1.6r$ apart, as shown in Figure 2.

The coefficient of restitution between the two spheres is $\frac{1}{6}$.

Find, in terms of m and u , the magnitude of the impulse received by B in the collision.

(10)

(Total 10 marks)

(Q05 6680/01, June 2013)

Q8.

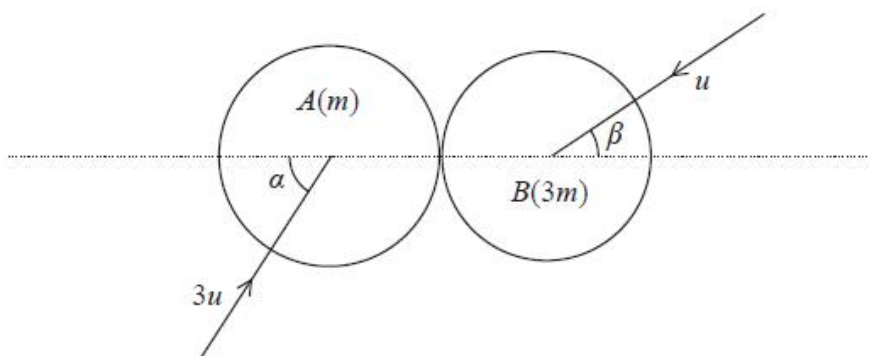


Figure 1

Two smooth uniform spheres A and B have equal radii. The mass of A is m and the mass of B is $3m$. The spheres are moving on a smooth horizontal plane when they collide obliquely. Immediately before the collision, A is moving with speed $3u$ at angle α to the line of centres and B is moving with speed u at angle β to the line of centres, as shown in Figure 1. The coefficient of restitution between the two spheres is $\frac{1}{5}$. It is given that $\cos\alpha = \frac{1}{3}$ and $\cos\beta = \frac{2}{3}$ and that α and β are both acute angles.

(a) Find the magnitude of the impulse on A due to the collision in terms of m and u .

(8)

(b) Express the kinetic energy lost by A in the collision as a fraction of its initial kinetic energy.

(4)

(Total 12 marks)

(Q06 6680/01, June 2014)



Q9.

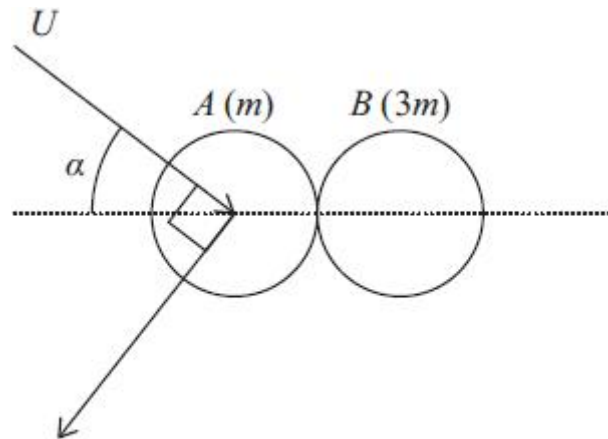


Figure 1

A smooth uniform sphere A of mass m is moving with speed U on a smooth horizontal plane. The sphere A collides obliquely with a smooth uniform sphere B of mass $3m$ which is at rest on the plane. The two spheres have the same radius.

Immediately before the collision, the direction of motion of A makes an angle α , where $0^\circ < \alpha < 90^\circ$, with the line joining the centres of the spheres.

Immediately after the collision, the direction of motion of A is **perpendicular** to its original direction, as shown in Figure 1.

The coefficient of restitution between the spheres is e .

(a) Show that the speed of B immediately after the collision is

$$\frac{1}{4}(1+e)U\cos\alpha \tag{6}$$

(b) Show that $e > \frac{1}{3}$ (4)

(c) Show that $0 < \tan\alpha \leq \frac{1}{\sqrt{2}}$ (5)

(Total for question = 15 marks)

(Q07 9FM0/03C, June 2024)



Q10.

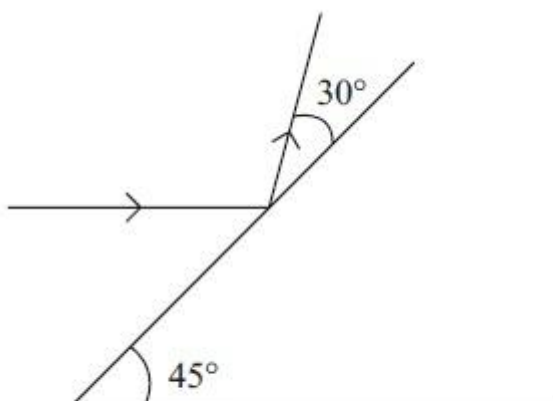


Figure 1

A fixed smooth plane is inclined to the horizontal at an angle of 45° . A particle P is moving horizontally and strikes the plane. Immediately before the impact, P is moving in a vertical plane containing a line of greatest slope of the inclined plane. Immediately after the impact, P is moving in a direction which makes an angle of 30° with the inclined plane, as shown in Figure 1.

Find the fraction of the kinetic energy of P which is lost in the impact.

(6)

(Total 6 marks)

(Q06 6680/01, June 2009)

Q11.

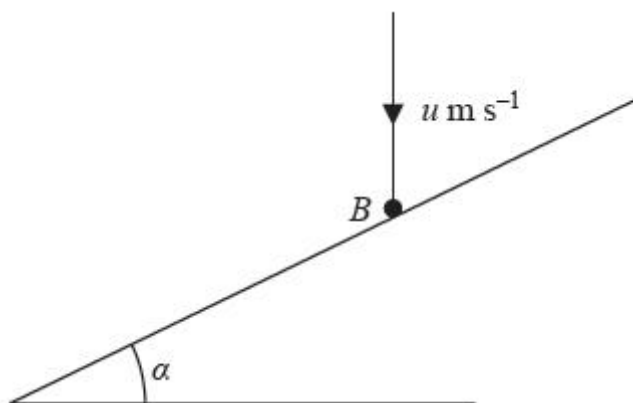


Figure 1

A smooth fixed plane is inclined at an angle α to the horizontal. A smooth ball B falls vertically and hits the plane. Immediately before the impact the speed of B is $u \text{ m s}^{-1}$, as shown in Figure 1. Immediately after the impact the

direction of motion of B is horizontal. The coefficient of restitution between B and the plane is $\frac{1}{3}$.

Find the size of angle α .

(6)

(Total 6 marks)

(Q05 6680/01/R, June 2013)



Q12.

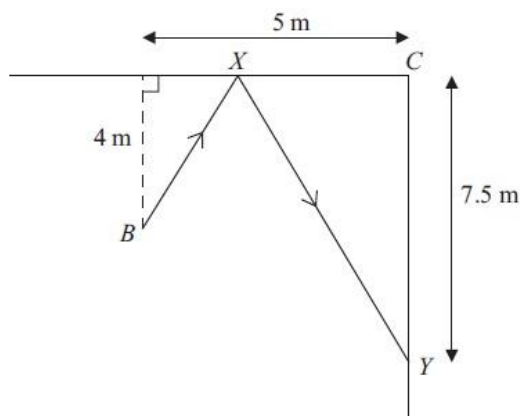


Figure 2

Figure 2 represents part of the smooth rectangular floor of a sports hall. A ball is at B , 4 m from one wall of the hall and 5 m from an adjacent wall. These two walls are smooth and meet at the corner C . The ball is kicked so that it travels along the floor, bounces off the first wall at the point X and hits the second wall at the point Y . The point Y is 7.5 m from the corner C .

The coefficient of restitution between the ball and the first wall is $\frac{3}{4}$.

Modelling the ball as a particle, find the distance CX .

(9)

(Total 9 marks)

(Q08 6680/01, June 2011)

Q13.

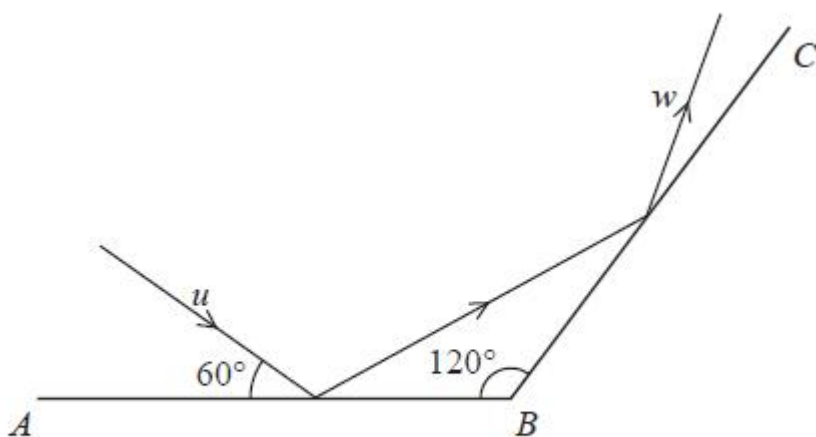


Figure 4

Figure 4 represents the plan view of part of a smooth horizontal floor, where AB and BC

are smooth vertical walls. The angle between AB and BC is 120° . A ball is projected along the floor towards AB with speed u m s^{-1} on a path at an angle of 60° to AB . The ball

hits AB and then hits BC . The ball is modelled as a particle. The coefficient of restitution

between the ball and each wall is $\frac{1}{2}$

(a) Show that the speed of the ball

$$\frac{\sqrt{7}}{4} u$$

immediately after it has hit AB is

(6)

The speed of the ball immediately after it has hit BC is w m s^{-1}

(b) Find w in terms of u .

(7)

(Total for question = 13 marks)

(Q06 6680/01, June 2015)



Q14.

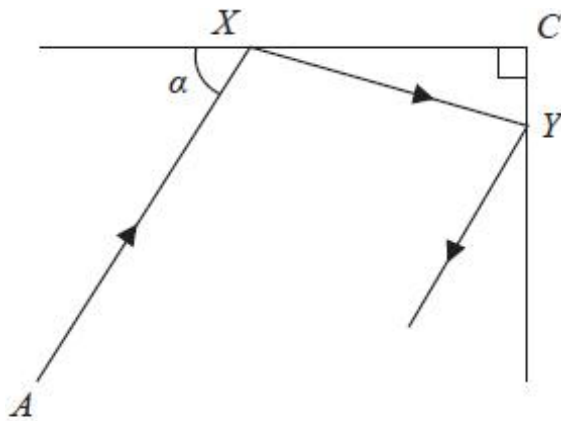


Figure 2

A small spherical ball P is at rest at the point A on a smooth horizontal floor. The ball is struck and travels along the floor until it hits a fixed smooth vertical wall at the point X . The angle between AX and this wall is α , where α is acute. A second fixed smooth vertical wall is perpendicular to the first wall and meets it in a vertical line through the point C on the floor. The ball rebounds from the first wall and hits the second wall at the point Y . After P rebounds from the second wall, P is travelling in a direction parallel to XA , as shown in Figure 2. The coefficient of restitution between the ball and the first wall is e . The coefficient of restitution between the ball and the second wall is ke .

Find the value of k .

(9)

(Total for question = 9 marks)

(Q06 6680/01, June 2016)

Q15.

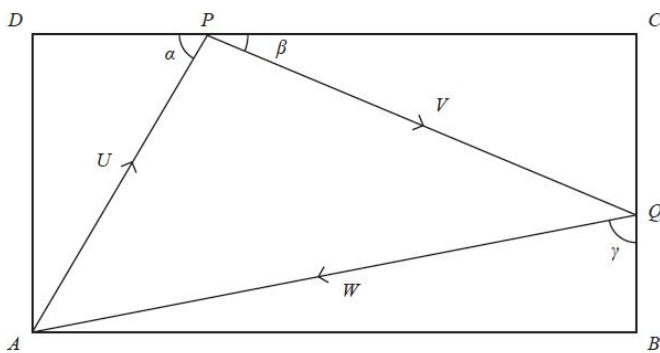


Figure 2

A small smooth snooker ball is projected from the corner A of a horizontal rectangular snooker table $ABCD$.

The ball is projected so it first hits the side DC at the point P , then hits the side CB at the point Q and then returns to A .

Angle $APD = \alpha$, Angle $QPC = \beta$, Angle $AQB = \gamma$

The ball moves along AP with speed U , along PQ with speed V and along QA with speed W , as shown in Figure 2.

The coefficient of restitution between the ball and side DC is e_1

The coefficient of restitution between the ball and side CB is e_2

The ball is modelled as a particle. Use the model to answer all parts of this question.

(a) Show that $\tan \beta = e_1 \tan \alpha$

(4)

(b) Hence show that $e_1 \tan \alpha = \cot \gamma$

(3)

(c) By considering (angle APQ + angle AQP) or otherwise, show that it would be possible for the ball to return to A only if $e_2 > e_1$

(6)

If instead $e_1 = e_2$, the ball would **not** return to A .

Given that $e_1 = e_2$

(d) use the result from part (b) to describe the path of the ball after it hits CB at Q , explaining your answer.

(1)

(Total for question = 14 marks)

(Q07 9FM0/03C, June 2023)