Momentum 2

Q1.

Two uniform small smooth spheres A and B, of masses m and $2m$ respectively, and with equal radii, are at rest on a smooth horizontal surface. Sphere A is projected directly towards B with speed u, and collides with B. After this collision, sphere B collides directly with a fixed smooth vertical barrier. The total kinetic energy of the spheres after this second collision is equal to one-ninth of its value before the first collision. Given that the coefficient of restitution between B and the barrier is 0.5, find the coefficient of restitution between A and B. [9]

Q2.

Three uniform small smooth spheres A, B and C, of equal radii and of masses $4m$, λm and m respectively, are at rest in a straight line on a smooth horizontal plane, with B between A and C. Sphere A is projected directly towards B with speed u. The coefficient of restitution between A and B, and between B and C, is $\frac{1}{2}$. Show that the speed of B after it is struck by A is $\dfrac{6u}{\lambda+4}$. [4]

Given that the speed of C after it is struck by B is u, find the value of λ. [5]

Q3.

Two small smooth spheres A and B have equal radii and have masses m and km respectively. They are moving in a straight line in the same direction on a smooth horizontal table. The speed of A is u and the speed of B is $\frac{2}{3}u$. Sphere A collides directly with sphere B. The coefficient of restitution between the spheres is $\frac{4}{5}$.

(i) Show that the speed of A after the collision is $\dfrac{u(2k+5)}{5(k+1)}$. [5]

(ii) Given that the magnitude of the impulse experienced by B during the collision is $\frac{2}{5}mu$, find the value of k. [2]

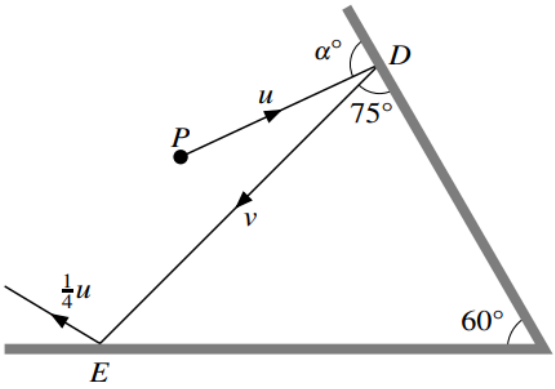
Q4.

Three uniform small smooth spheres A, B and C have equal radii and masses $3m$, $2m$ and m respectively. The spheres are at rest in a straight line on a smooth horizontal surface, with B between A and C. The coefficient of restitution between A and B is e and the coefficient of restitution between B and C is e'. Sphere A is projected directly towards B with speed u. Show that, after the collision between B and C, the speed of C is $\frac{2}{5}u(1+e)(1+e')$ and find the corresponding speed of B. [7]

After this collision between B and C it is found that each of the three spheres has the same momentum. Find the values of e and e'. [5]

Momentum 2

Q5.



Two smooth vertical walls each with their base on a smooth horizontal surface intersect at an angle of 60°. A small smooth sphere P is moving on the horizontal surface with speed u when it collides with the first vertical wall at the point D. The angle between the direction of motion of P and the wall is $\alpha°$ before the collision and 75° after the collision. The speed of P after this collision is v and the coefficient of restitution between P and the first wall is e. Sphere P then collides with the second vertical wall at the point E. The speed of P after this second collision is $\frac{1}{4}u$ (see diagram). The coefficient of restitution between P and the second wall is $\frac{3}{4}$.

(i) By considering the collision at E, show that $v = \frac{\sqrt{2}}{5}u$. [5]

(ii) Find the value of α and the value of e. [5]

Q6.

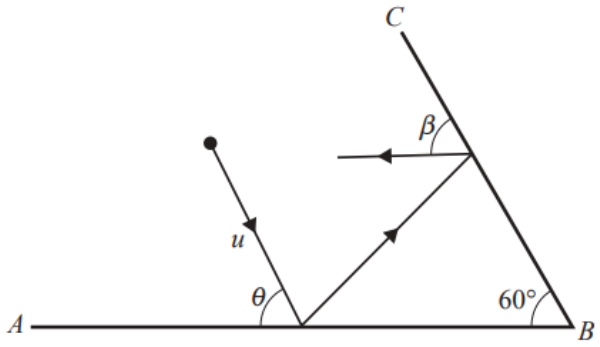
Two uniform small smooth spheres A and B have equal radii and each has mass m. Sphere A is moving with speed u on a smooth horizontal surface when it collides directly with sphere B which is at rest. The coefficient of restitution between the spheres is $\frac{2}{3}$. Sphere B is initially at a distance d from a fixed smooth vertical wall which is perpendicular to the direction of motion of A. The coefficient of restitution between B and the wall is $\frac{1}{3}$.

(i) Show that the speed of B after its collision with the wall is $\frac{5}{18}u$. [4]

(ii) Find the distance of B from the wall when it collides with A for the second time. [6]

Momentum 2

Q7.



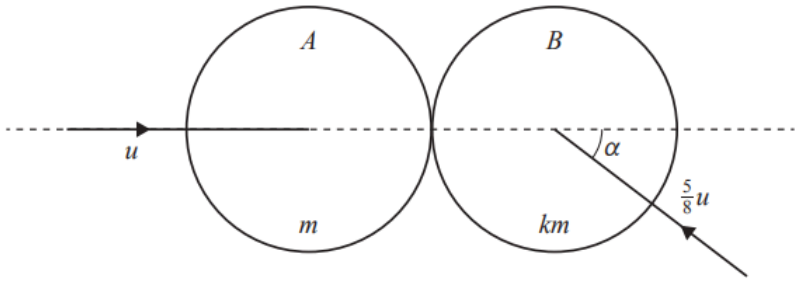
AB and BC are two fixed smooth vertical barriers on a smooth horizontal surface, with angle $ABC = 60°$. A particle of mass m is moving with speed u on the surface. The particle strikes AB at an angle θ with AB. It then strikes BC and rebounds at an angle β with BC (see diagram). The coefficient of restitution between the particle and each barrier is e and $\tan\theta = 2$.

The kinetic energy of the particle after the first collision is 40% of its kinetic energy before the first collision.

(a) Find the value of e. [4]

(b) Find the size of angle β. [4]

Q8.



Two uniform smooth spheres A and B of equal radii have masses m and km respectively. The two spheres are moving on a horizontal surface with speeds u and $\frac{5}{8}u$ respectively. Immediately before the spheres collide, A is travelling along the line of centres, and B's direction of motion makes an angle α with the line of centres (see diagram). The coefficient of restitution between the spheres is $\frac{2}{3}$ and $\tan\alpha = \frac{3}{4}$.

After the collision, the direction of motion of B is perpendicular to the line of centres.

(a) Find the value of k. [4]

(b) Find the loss in the total kinetic energy as a result of the collision. [4]
