

QQQ – Further Mechanics 1 – Chapter 5 – Collisions in Two Dimensions (Version 1)

Total Marks: 25

(25 = Platinum, 23 = Gold, 20 = Silver, 17 = Bronze)

1.

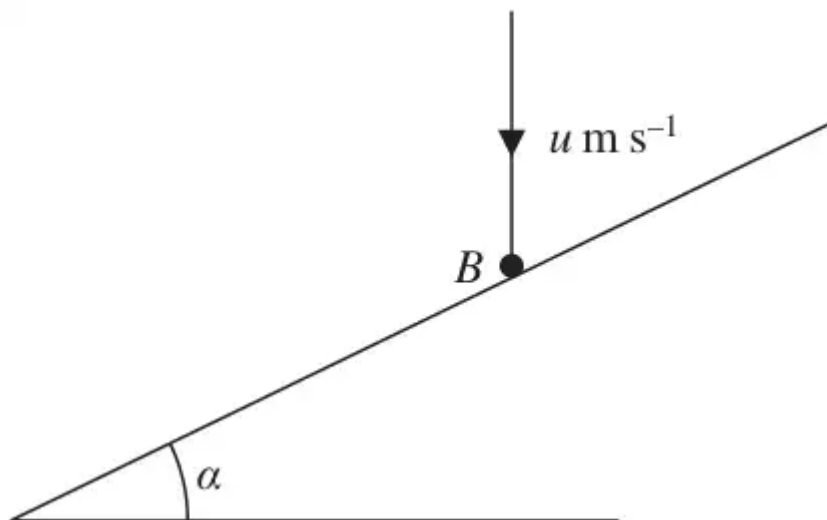


Figure 1

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)

2.

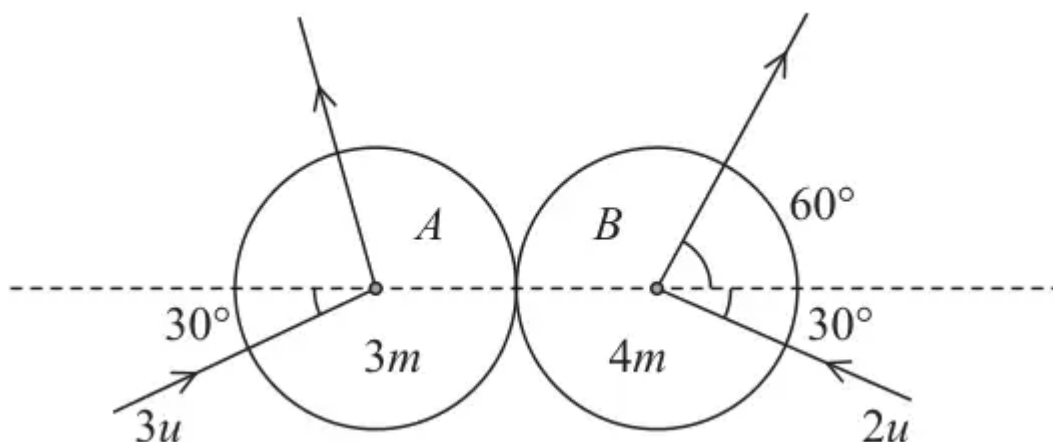


Figure 3

Two smooth uniform spheres, A and B , have equal radii. The mass of A is $3m$ and the mass of B is $4m$. The spheres are moving on a smooth horizontal plane when they collide obliquely. Immediately before they collide, A is moving with speed $3u$ at 30° to the line of centres of the spheres and B is moving with speed $2u$ at 30° to the line of centres of the spheres. The direction of motion of B is turned through an angle of 90° by the collision, as shown in Figure 3.

- (i) Find the size of the angle through which the direction of motion of A is turned as a result of the collision.
- (ii) Find, in terms of m and u , the magnitude of the impulse received by B in the collision.

(9)

(Total 9 marks)

3.

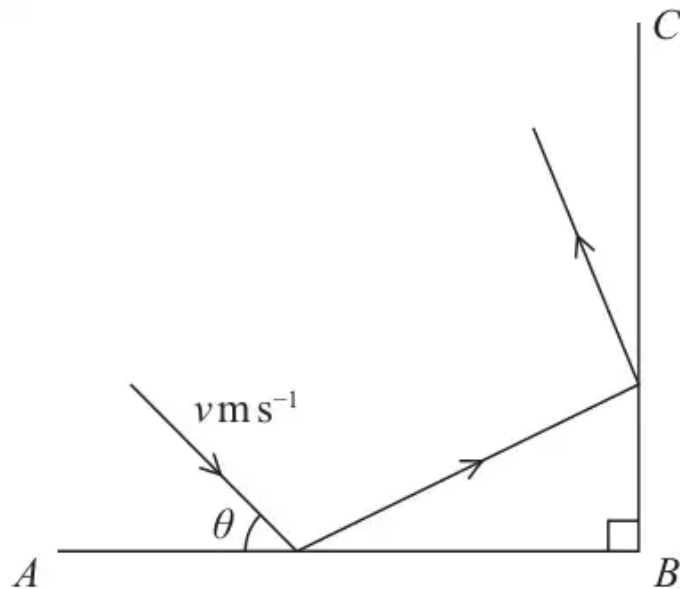


Figure 1

Figure 1 represents the plan view of part of a horizontal floor, where AB and BC represent fixed vertical walls, with AB perpendicular to BC .

A small ball is projected along the floor towards the wall AB . Immediately before hitting the wall AB the ball is moving with speed $v \text{ m s}^{-1}$ at an angle θ to AB .

The ball hits the wall AB and then hits the wall BC .

The coefficient of restitution between the ball and the wall AB is $\frac{1}{3}$.

The coefficient of restitution between the ball and the wall BC is e .

The floor and the walls are modelled as being smooth.

The ball is modelled as a particle.

The ball loses half of its kinetic energy in the impact with the wall AB .

(a) Find the exact value of $\cos \theta$. (5)

The ball loses half of its remaining kinetic energy in the impact with the wall BC .

(b) Find the exact value of e . (5)

(Total 10 marks)