

QQQ – Further Mechanics 1 – Chapter 5 – Collisions in Two Dimensions (Version 2)

Total Marks: 25

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

1. Two small smooth spheres A and B have equal radii. The mass of A is $2m$ kg and the mass of B is m kg. The spheres are moving on a smooth horizontal plane and they collide. Immediately before the collision the velocity of A is $(2\mathbf{i} - 2\mathbf{j}) \text{ m s}^{-1}$ and the velocity of B is $(-3\mathbf{i} - \mathbf{j}) \text{ m s}^{-1}$. Immediately after the collision the velocity of A is $(\mathbf{i} - 3\mathbf{j}) \text{ m s}^{-1}$.

Find the speed of B immediately after the collision.

(5)

(Total 5 marks)

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2. [In this question, $\mathbf{i}$ and $\mathbf{j}$ are perpendicular unit vectors in a horizontal plane.]

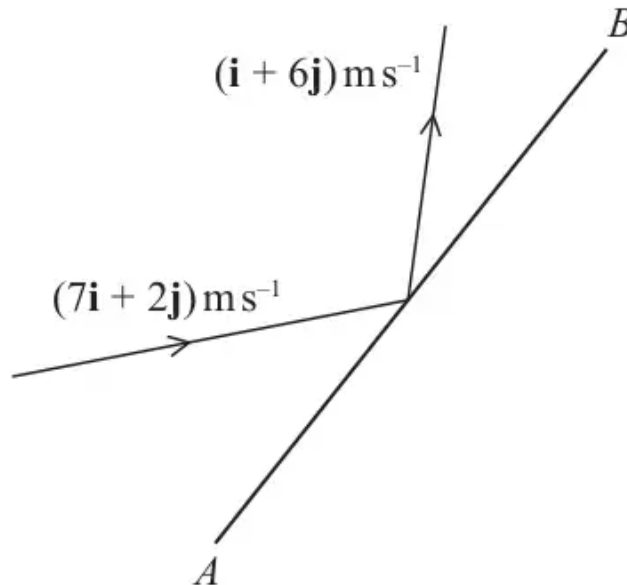


Figure 1

Figure 1 represents the plan view of part of a smooth horizontal floor, where AB represents a fixed smooth vertical wall.

A small ball of mass 0.5 kg is moving on the floor when it strikes the wall.

Immediately before the impact the velocity of the ball is $(7\mathbf{i} + 2\mathbf{j}) \text{ m s}^{-1}$.

Immediately after the impact the velocity of the ball is $(\mathbf{i} + 6\mathbf{j}) \text{ m s}^{-1}$.

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

(a) Show that AB is parallel to $(2\mathbf{i} + 3\mathbf{j})$. (4)

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

(Total 9 marks)

3.

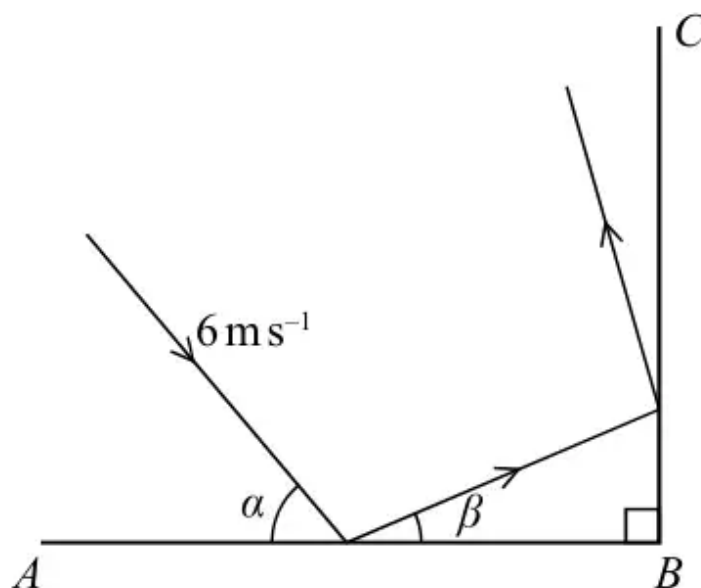


Figure 2

Figure 2 represents the plan view of part of a horizontal floor, where AB and BC are fixed vertical walls with AB perpendicular to BC .

A small ball is projected along the floor towards AB with speed 6 m s^{-1} on a path that makes an angle α with AB , where $\tan \alpha = \frac{4}{3}$. The ball hits AB and then hits BC .

Immediately after hitting AB , the ball is moving at an angle β to AB , where $\tan \beta = \frac{1}{3}$

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

The coefficient of restitution between the ball and BC is $\frac{1}{2}$

By modelling the ball as a particle and the floor and walls as being smooth,

- (a) show that the value of $e = \frac{1}{4}$ (5)
- (b) find the speed of the ball immediately after it hits BC . (4)
- (c) Suggest two ways in which the model could be refined to make it more realistic. (2)

(Total 11 marks)