

QQQ – Further Mechanics 1 – Chapter 4 – Collisions in One Dimension (Version 1)

Total Marks: 25

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

1. A small ball of mass 0.3 kg is released from rest from a point 3.6 m above horizontal ground. The ball falls freely under gravity, hits the ground and rebounds vertically upwards.

In the first impact with the ground, the ball receives an impulse of magnitude 4.2 N s. The ball is modelled as a particle.

- (a) Find the speed of the ball immediately after it first hits the ground. (5)
- (b) Find the kinetic energy lost by the ball as a result of the impact with the ground. (3)

(Total 8 marks)

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2. A particle A has mass $2m$ and a particle B has mass $3m$. The particles are moving in opposite directions along the same straight line and collide directly.

Immediately **before** the collision, the speed of A is $2u$ and the speed of B is u .

Immediately **after** the collision, the speed of A is $0.5u$ and the speed of B is w .

Given that the direction of motion of each particle is reversed by the collision,

- (a) find w in terms of u (3)
- (b) find the coefficient of restitution between the particles, (3)
- (c) find, in terms of m and u , the magnitude of the impulse received by A in the collision. (3)

(Total 9 marks)

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3.

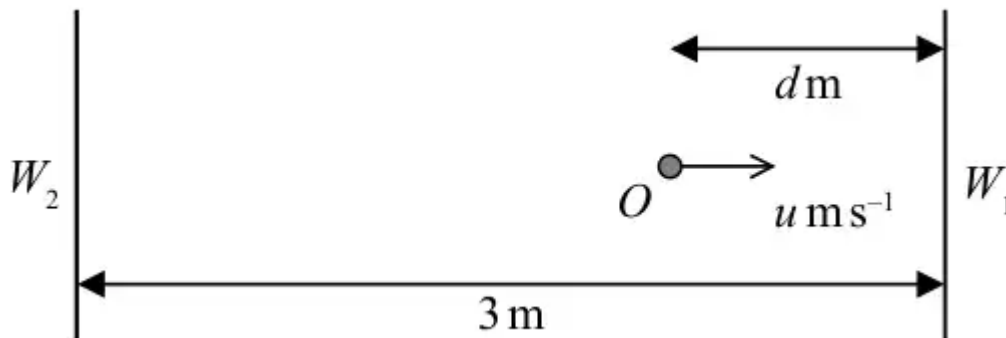


Figure 1

Figure 1 represents the plan of part of a smooth horizontal floor, where W_1 and W_2 are two fixed parallel vertical walls. The walls are 3 metres apart.

A particle lies at rest at a point O on the floor between the two walls, where the point O is d metres, $0 < d \leq 3$, from W_1

At time $t = 0$, the particle is projected from O towards W_1 with speed $u\text{ m s}^{-1}$ in a direction perpendicular to the walls.

The coefficient of restitution between the particle and each wall is $\frac{2}{3}$

The particle returns to O at time $t = T$ seconds, having bounced off each wall once.

(a) Show that $T = \frac{45 - 5d}{4u}$ (6)

The value of u is fixed, the particle still hits each wall once but the value of d can now vary.

(b) Find the least possible value of T , giving your answer in terms of u . You must give a reason for your answer. (2)

(Total 8 marks)