

QQQ – Further Mechanics 1 - Chapter 1 – Impulse and Momentum (v2)

Total Marks: 26

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

1.

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

A ball has mass 0.2 kg. It is moving with velocity $(30\mathbf{i}) \text{ m s}^{-1}$ when it is struck by a bat. The bat exerts an impulse of $(-4\mathbf{i} + 4\mathbf{j}) \text{ Ns}$ on the ball.

Find

(a) the velocity of the ball immediately after the impact, (3)

(b) the angle through which the ball is deflected as a result of the impact, (2)

2.

Two particles A and B , of mass 3 kg and 2 kg respectively, are moving in the same direction on a smooth horizontal table when they collide directly. Immediately before the collision, the speed of A is 4 m s^{-1} and the speed of B is 1.5 m s^{-1} . In the collision, the particles join to form a single particle C .

(a) Find the speed of C immediately after the collision. (3)

Two particles P and Q have mass 3 kg and m kg respectively. They are moving towards each other in opposite directions on a smooth horizontal table. Each particle has speed 4 m s^{-1} , when they collide directly. In this collision, the direction of motion of each particle is reversed. The speed of P immediately after the collision is 2 m s^{-1} and the speed of Q is 1 m s^{-1} .

(b) Find

(i) the value of m , (3)

(ii) the magnitude of the impulse exerted on Q in the collision. (2)

3.

A ball of mass 0.2 kg is projected vertically downwards with speed $U \text{ m s}^{-1}$ from a point A which is 2.5 m above horizontal ground. The ball hits the ground. Immediately after hitting the ground, the ball rebounds vertically with a speed of 10 m s^{-1} . The ball receives an impulse of magnitude 7 N s in its impact with the ground. By modelling the ball as a particle and ignoring air resistance, find

(a) the value of U .

(6)

After hitting the ground, the ball moves vertically upwards and passes through a point B which is 1 m above the ground.

(b) Find the time between the instant when the ball hits the ground and the instant when the ball first passes through B .

(4)

(c) Sketch a velocity-time graph for the motion of the ball from when it was projected from A to when it first passes through B . (You need not make any further calculations to draw this sketch.)

(3)