

# Momentum & Impulse

Momentum & Impulse in 1D / Momentum & Impulse with Vectors

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Total Marks

/38

- 1 A particle  $P$  of mass  $0.5 \text{ kg}$  is moving with velocity  $(4\mathbf{i} + \mathbf{j}) \text{ ms}^{-1}$  when it receives an impulse  $(2\mathbf{i} - \mathbf{j}) \text{ N s}$ .

Show that the kinetic energy gained by  $P$  as a result of the impulse is  $12 \text{ J}$ .

**(6 marks)**

- 2 (a)** 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 Ns.  
The ball is modelled as a particle.

Find the speed of the ball immediately after it first hits the ground.

**(5 marks)**

- (b)** Find the kinetic energy lost by the ball as a result of the impact with the ground.

**(3 marks)**

- 3** A particle  $P$ , of mass 0.5 kg, is moving with velocity  $(4\mathbf{i} + 4\mathbf{j}) \text{ ms}^{-1}$  when it receives an impulse  $\mathbf{I}$  of magnitude 2.5 Ns.

As a result of the impulse, the direction of motion of  $P$  is deflected through an angle of  $45^\circ$ .

Given that  $\mathbf{I} = (\lambda\mathbf{i} + \mu\mathbf{j}) \text{ Ns}$ , find all the possible pairs of values of  $\lambda$  and  $\mu$ .

**(9 marks)**

- 4 (a)** A particle  $P$  of mass  $0.5 \text{ kg}$  is moving with velocity  $(4\mathbf{i} + 3\mathbf{j}) \text{ ms}^{-1}$  when it receives an impulse  $\mathbf{J} \text{ N s}$ . Immediately after receiving the impulse,  $P$  is moving with velocity  $(-\mathbf{i} + 6\mathbf{j}) \text{ ms}^{-1}$ .

Find the magnitude of  $\mathbf{J}$ .

**(4 marks)**

- (b)** The angle between the direction of the impulse and the direction of motion of  $P$  immediately before receiving the impulse is  $\alpha^\circ$ .

Find the value of  $\alpha$ .

**(3 marks)**

- 5** A particle  $P$  has mass  $0.5 \text{ kg}$ . It is moving in the  $xy$  plane with velocity  $8\mathbf{i} \text{ ms}^{-1}$  when it receives an impulse  $\lambda(-\mathbf{i} + \mathbf{j}) \text{ N s}$ , where  $\lambda$  is a positive constant.

The angle between the direction of motion of  $P$  immediately before receiving the impulse and the direction of motion of  $P$  immediately after receiving the impulse is  $\theta^\circ$

Immediately after receiving the impulse,  $P$  is moving with speed  $4\sqrt{10} \text{ ms}^{-1}$ .

Find

- i) the value of  $\lambda$
- ii) the value of  $\theta$

**(8 marks)**