## 1A Momentum in One Dimension

## Momentum:

Impulse:

1. Find the magnitude of the momentum of:
a) A cricket ball of mass 400 g moving at $18 \mathrm{~ms}^{-1}$
b) A lorry of mass 5 tonnes moving at $12 \mathrm{~ms}^{-1}$
2. A body of mass 2 kg is initially at rest on a smooth horizontal plane. A horizontal force of magnitude 4.5 N acts on the body for 6 s . Find:
a) The magnitude of the impulse given to the body by the force
b) The final speed of the body
3. A ball of mass 0.2 kg hits a vertical wall at right angles with a speed of $3.5 \mathrm{~ms}^{-1}$. The ball rebounds from the wall with speed $2.5 \mathrm{~ms}^{-1}$. Find the magnitude of the impulse the ball exerts on the wall.

## 1B Conservation of Momentum

1. A particle of mass 2 kg is moving with speed $3 \mathrm{~ms}^{-1}$ on a smooth horizontal plane. Particle Q of mass 3 kg is at rest on the plane. Particle $P$ collides with $Q$ and after the collision $Q$ moves away with a speed of $2^{1} / 3 \mathrm{~ms}^{-1}$. Find:
a) The speed and direction of the motion of $P$ after the collision
b) The magnitude of the impulse received by $P$ and by $Q$ in the collision
2. Two particles, $P$ and $Q$ of mass 2 kg and 4 kg respectively are moving towards each other along the same straight line on a smooth horizontal plane. The particles collide. Before the collision, the speeds of P and Q are $3 \mathrm{~ms}^{-1}$ and $2 \mathrm{~ms}^{-1}$. Given that the magnitude of the impulse due to the collision is 7 Ns , find:
a) The speed and direction of $P$ after the collision
b) The speed and direction of $Q$ after the collision
3. Two particles, $A$ and $B$, of masses 8 kg and 2 kg respectively, are connected by a light inextensible string. The particles are at rest on a smooth horizontal plane with the string slack. Particle A is projected directly away from B with speed $4 \mathrm{~ms}^{-1}$.
a) Find the speed of the particles when the string goes taut
b) Find the magnitude of the impulse transmitted through the string when it goes taut

## 1C Momentum as a Vector (Not AS)

1. A particle of mass 0.2 kg is moving with velocity $(10 \boldsymbol{i}-5 \boldsymbol{j}) \mathrm{ms}^{-1}$ when it receives an impulse $(3 \boldsymbol{i}-2 \boldsymbol{j}) N s$. Find the new velocity of the particle.
2. An ice hockey puck of mass 0.17 kg receives an impulse $\mathbf{Q}$ Ns. Immediately before the impulse the velocity of the puck is $(10 \boldsymbol{i}+5 \boldsymbol{j}) \mathrm{ms}^{-1}$ and immediately afterwards its velocity is $(15 \boldsymbol{i}-7 \boldsymbol{j}) \mathrm{ms}^{-1}$. Find the magnitude of $\mathbf{Q}$ and the angle between $\mathbf{Q}$ and $\mathbf{i}$.
3. A particle of mass 0.15 kg is moving with velocity $(20 \boldsymbol{i}-10 \boldsymbol{j}) \mathrm{ms}^{-1}$ when it collides with a particle of mass 0.25 kg moving with velocity $(16 \boldsymbol{i}-8 \boldsymbol{j}) \mathrm{ms}^{-1}$. The two particles coalesce and form one particle of mass 0.4 kg . Find the velocity of the combined particle.
