

## 1.3) Momentum as a vector

## Worked example

A particle of mass  $0.4\text{kg}$  is moving with velocity  $(5\mathbf{i} - 10\mathbf{j})\text{ms}^{-1}$  when it receives an impulse  $(2\mathbf{i} - 3\mathbf{j})\text{Ns}$ . Find the new velocity of the particle.

## Your turn

A particle of mass  $0.2\text{kg}$  is moving with velocity  $(10\mathbf{i} - 5\mathbf{j})\text{ms}^{-1}$  when it receives an impulse  $(3\mathbf{i} - 2\mathbf{j})\text{Ns}$ . Find the new velocity of the particle.

$$(25\mathbf{i} - 15\mathbf{j})\text{ms}^{-1}$$

## Worked example

An ice hockey puck of mass 0.34 kg receives an impulse  $\mathbf{Q}$  Ns .

Immediately before the impulse the velocity of the puck is  $(5\mathbf{i} + 10\mathbf{j}) \text{ ms}^{-1}$  and immediately afterwards its velocity is  $(7\mathbf{i} - 15\mathbf{j}) \text{ ms}^{-1}$ .

Find the magnitude of  $\mathbf{Q}$  and the angle between  $\mathbf{Q}$  and  $\mathbf{i}$ .

## Your turn

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  $(10\mathbf{i} + 5\mathbf{j}) \text{ ms}^{-1}$  and immediately afterwards its velocity is  $(15\mathbf{i} - 7\mathbf{j}) \text{ ms}^{-1}$ .

Find the magnitude of  $\mathbf{Q}$  and the angle between  $\mathbf{Q}$  and  $\mathbf{i}$ .

$$|\mathbf{Q}| = 2.21$$

$$\text{Angle between } \mathbf{Q} \text{ and } \mathbf{i} = 67.4^\circ \text{ (1 dp)}$$

## Worked example

A squash ball of mass  $0.05 \text{ kg}$  is moving with velocity  $(44\mathbf{i} + 74\mathbf{j}) \text{ ms}^{-1}$  when it hits a wall. It rebounds with velocity  $(20\mathbf{i} - 22\mathbf{j}) \text{ ms}^{-1}$ . Find the impulse exerted by the wall on the squash ball.

## Your turn

A squash ball of mass  $0.025 \text{ kg}$  is moving with velocity  $(22\mathbf{i} + 37\mathbf{j}) \text{ ms}^{-1}$  when it hits a wall. It rebounds with velocity  $(10\mathbf{i} - 11\mathbf{j}) \text{ ms}^{-1}$ . Find the impulse exerted by the wall on the squash ball.

$$(-0.3\mathbf{i} - 1.2\mathbf{j}) \text{ Ns}$$

## Worked example

A particle of mass  $0.3 \text{ kg}$  is moving with velocity  $(10\mathbf{i} - 20\mathbf{j}) \text{ ms}^{-1}$  when it collides with a particle of mass  $0.5 \text{ kg}$  moving with velocity  $(8\mathbf{i} - 16\mathbf{j}) \text{ ms}^{-1}$ .

The two particles coalesce and move as one particle of mass  $0.8 \text{ kg}$ .

Find the velocity of the combined particle.

## Your turn

A particle of mass  $0.15 \text{ kg}$  is moving with velocity  $(20\mathbf{i} - 10\mathbf{j}) \text{ ms}^{-1}$  when it collides with a particle of mass  $0.25 \text{ kg}$  moving with velocity  $(16\mathbf{i} - 8\mathbf{j}) \text{ ms}^{-1}$ .

The two particles coalesce and move as one particle of mass  $0.4 \text{ kg}$ .

Find the velocity of the combined particle.

$$(17.5\mathbf{i} - 8.75\mathbf{j}) \text{ ms}^{-1}$$