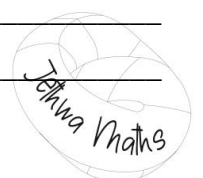




Don't risk it, draw a diagram!

1. A particle P of mass 3 kg is moving with a speed of 8 ms^{-1} in a straight horizontal line when it collides with particle Q , of mass 4 kg, which is moving in the opposite direction with speed 1.5 ms^{-1} . After the collision, the direction of motion of P is unchanged and it moves with a speed of 2 ms^{-1} . The direction of motion of Q is reversed. Find the speed of Q after the collision. (3)

2. An ice hockey puck, of mass 0.2 kg, is moving along smooth horizontal ice with a speed of 10 m s^{-1} when it receives a direct hit from a stick which reverses its direction and increases its speed to 15 m s^{-1} . Calculate the magnitude of the impulse exerted by the stick on the puck. (2)



Solutions

1.

$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$	M1
$3 \times 8 + 4 \times -1.5 = 3 \times 2 + 4v$	M1
$v = 3 \text{ ms}^{-1}$	A1

2.

$I = m(v - u)$	M1
$I = 0.2(15 - (-10)) = 5 \text{ Ns}$	A1



Solution

1.

Using conservation of linear momentum	M1
$4(3\mathbf{i} + 5\mathbf{j}) + 2(-2\mathbf{i} + 4\mathbf{j}) = 4\mathbf{v}$	A1
$12\mathbf{i} + 20\mathbf{j} - 4\mathbf{i} + 8\mathbf{j} = 4\mathbf{v}$	A1
$\mathbf{v} = \frac{8\mathbf{i} + 28\mathbf{j}}{4} = 2\mathbf{i} + 7\mathbf{j}$	A1
Speed of A = $\sqrt{2^2 + 7^2} = \sqrt{53} = 7.23 \text{ ms}^{-1}$	A1
The direction: $\theta = \tan^{-1}\left(\frac{7}{2}\right)$	M1
$\theta = 74.1^\circ$ So A makes an angle of 74.1° with the unit vector \mathbf{i}	A1



Solutions

1a.

Consider P and use $I = mv - mu$ Take $\leftarrow = +$	M1
$I = 3(-1) - 3(-4)$	M1
$I = 9 \text{ Ns}$	A1

1b.

Consider Q and use $I = mv - mu$ Take $\rightarrow = +$	M1
$9 = m(1.5) - m(-3)$ $9 = 1.5m + 3m$ $9 = 4.5m$	M1
$m = 2$	A1



Further Maths
A-Level Starter
Activity



Topic: Momentum and Impulse (4)

Chapter Reference: Further Mechanics 1, Chapter 1

**8
minutes**

1. Two particles P and Q have masses $4m$ and m respectively. The particles are moving towards each other on a smooth horizontal plane and collide directly.

The speeds of P and Q immediately before the collision are $2u$ and $5u$ respectively. Immediately after the collision, the speed of P is $\frac{1}{2}u$ and its direction of motion is reversed.

a. Find the speed and direction of Q after the collision (4)

b. Find the magnitude of the impulse exerted on P by Q in the collision. (3)



Solutions

1a.

$4m(2u) - m(5u) = -4m\left(\frac{1}{2}u\right) + mv$	M1
$3mu = -2mu + mv$	M1
$v = 5u$	A1
Opposite direction	A1

1b.

Use of $I = mv - mu$	M1
$I = 4m\left(\frac{1}{2}u - -2u\right)$ or $I = m(5u - -5u)$	M1
$= 10 mu$	A1



Further Maths A-Level Starter Activity



Topic: Momentum and Impulse (5)

Chapter Reference: Further Mechanics 1, Chapter 1

**6
minutes**

1. A tennis ball of mass 0.1 kg is hit by a racquet. Immediately before being hit, the ball has a velocity $30 \mathbf{i} \text{ ms}^{-1}$. The racquet exerts an impulse of $(-2\mathbf{i} - 4\mathbf{j})$ Ns on the ball. By modelling the ball as a particle, find the velocity of the ball immediately after being hit. (4)



Solutions

1.

Use of $m(v - u) = I$	M1
$0.1 \times (v - 30\mathbf{i}) = -2\mathbf{i} - 4\mathbf{j}$	M1
Solve for v : $0.1v = 3\mathbf{i} - 2\mathbf{i} - 4\mathbf{j} = \mathbf{i} - 4\mathbf{j}$	M1
$v = 10\mathbf{i} - 40\mathbf{j}$	A1

