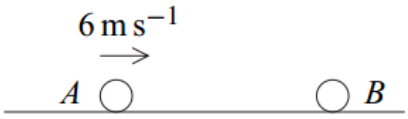
Mechanics 1: Momentum

Past Exam Questions
2006 - 2013

Name:

January 2006

1 A particle A moves across a smooth horizontal surface in a straight line. The particle A has mass 2 kg and speed $6\,\text{m s}^{-1}$. A particle B, which has mass 3 kg, is at rest on the surface. The particle A collides with the particle B.



(a) If, after the collision, A is at rest and B moves away from A, find the speed of B.

(3 marks)

(b) If, after the collision, A and B move away from each other with speeds $v\,\text{m s}^{-1}$ and $4v\,\text{m s}^{-1}$ respectively, as shown in the diagram below, find the value of v.

(3 marks)

June 2006

8 Two particles, A and B, are moving on a smooth horizontal surface.

The particle A has mass m kg and is moving with velocity $\begin{bmatrix} 5 \\ -3 \end{bmatrix}\,\text{m s}^{-1}$.

The particle B has mass 0.2 kg and is moving with velocity $\begin{bmatrix} 2 \\ 3 \end{bmatrix}\,\text{m s}^{-1}$.

(a) Find, in terms of m, an expression for the total momentum of the particles. *(2 marks)*

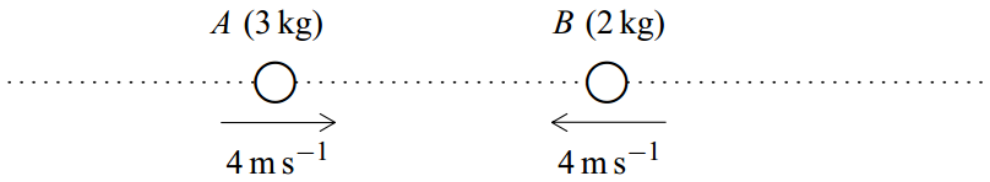
(b) The particles A and B collide and form a single particle C, which moves with velocity $\begin{bmatrix} k \\ 1 \end{bmatrix}\,\text{m s}^{-1}$, where k is a constant.

(i) Show that $m = 0.1$. *(3 marks)*

(ii) Find the value of k. *(3 marks)*

January 2007

1 Two particles A and B have masses of 3 kg and 2 kg respectively. They are moving along a straight horizontal line towards each other. Each particle is moving with a speed of $4\,\text{m s}^{-1}$ when they collide.



(a) If the particles coalesce during the collision to form a single particle, find the speed of the combined particle after the collision. *(3 marks)*

(b) If, after the collision, A moves in the same direction as before the collision with speed $0.4\,\text{m s}^{-1}$, find the speed of B after the collision. *(3 marks)*

June 2007

2 Two particles, A and B, are moving on a smooth horizontal surface. Particle A has mass 2 kg and velocity $\begin{bmatrix} 3 \\ -2 \end{bmatrix}\,\text{m s}^{-1}$. Particle B has mass 3 kg and velocity $\begin{bmatrix} -4 \\ 1 \end{bmatrix}\,\text{m s}^{-1}$. The two particles collide, and they coalesce during the collision.

(a) Find the velocity of the combined particles after the collision. *(3 marks)*

(b) Find the speed of the combined particles after the collision. *(2 marks)*

January 2008

4 Two particles, A and B, are moving on a horizontal plane when they collide and coalesce to form a single particle. The mass of A is 5 kg and the mass of B is 15 kg. Before the collision, the velocity of A is $\begin{bmatrix} 2U \\ U \end{bmatrix}\,\text{m s}^{-1}$ and the velocity of B is $\begin{bmatrix} V \\ -1 \end{bmatrix}\,\text{m s}^{-1}$. After the collision, the velocity of the combined particle is $\begin{bmatrix} V \\ 0 \end{bmatrix}\,\text{m s}^{-1}$.

(a) Find:

(i) U; *(3 marks)*

(ii) V. *(2 marks)*

(b) Find the speed of A before the collision. *(2 marks)*

June 2008

8 Two particles, A and B, are travelling towards each other along a straight horizontal line.

Particle A has velocity $2\,\text{m s}^{-1}$ and mass m kg.
Particle B has velocity $-2\,\text{m s}^{-1}$ and mass 3 kg.

The particles collide.

(a) If the particles move in opposite directions after the collision, each with speed $0.5\,\text{m s}^{-1}$, find the value of m. *(3 marks)*

(b) If the particles coalesce during the collision, forming a single particle which moves with speed $0.5\,\text{m s}^{-1}$, find the two possible values of m. *(5 marks)*

January 2009

1 Two particles, A and B, are travelling in the same direction with constant speeds along a straight line when they collide. Particle A has mass 2.5 kg and speed $12\,\text{m s}^{-1}$. Particle B has mass 1.5 kg and speed $4\,\text{m s}^{-1}$. After the collision, the two particles move together at the same speed.

Find the speed of the particles after the collision. *(3 marks)*

June 2009

1 Two particles, A and B, are moving on a smooth horizontal surface when they collide. During the collision, the two particles coalesce to form a single combined particle. Particle A has mass 3 kg and particle B has mass 7 kg.

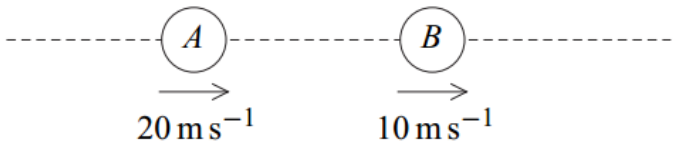
Before the collision, the velocity of A is $\begin{bmatrix} 6 \\ -2 \end{bmatrix}\,\text{m s}^{-1}$ and the velocity of B is $\begin{bmatrix} -1 \\ 4 \end{bmatrix}\,\text{m s}^{-1}$.

(a) Find the velocity of the combined particle after the collision. *(3 marks)*

(b) Find the speed of the combined particle after the collision. *(2 marks)*

January 2010

1 Two particles, A and B, are travelling in the same direction along a straight line on a smooth horizontal surface. Particle A has mass 3 kg and particle B has mass 7 kg. Particle A has a speed of $20\,\text{m s}^{-1}$ and particle B has a speed of $10\,\text{m s}^{-1}$, as shown in the diagram.



Particle A and particle B collide and coalesce to form a single particle. Find the speed of this single particle after the collision. *(3 marks)*

June 2010

3 Two particles, A and B, are moving on a smooth horizontal plane when they collide. The mass of A is 6 kg and the mass of B is m kg. Before the collision, the velocity of A is $\begin{bmatrix} 2 \\ 4 \end{bmatrix}\,\text{m s}^{-1}$ and the velocity of B is $\begin{bmatrix} 3 \\ -2 \end{bmatrix}\,\text{m s}^{-1}$. After the collision, the velocity of A is $\begin{bmatrix} 1 \\ 3 \end{bmatrix}\,\text{m s}^{-1}$ and the velocity of B is $\begin{bmatrix} 7 \\ b \end{bmatrix}\,\text{m s}^{-1}$.

(a) Find m. *(4 marks)*

(b) Find b. *(2 marks)*

January 2011

1 A trolley, of mass 5 kg, is moving in a straight line on a smooth horizontal surface. It has a velocity of $6\,\text{m s}^{-1}$ when it collides with a stationary trolley, of mass m kg. Immediately after the collision, the trolleys move together with velocity $2.4\,\text{m s}^{-1}$.

Find m. *(3 marks)*

June 2011

4 Two particles, A and B, are moving on a smooth horizontal surface when they collide. The mass of A is 6 kg and the mass of B is m kg. Before the collision, the velocity of A is $(5\mathbf{i} + 18\mathbf{j})\,\text{m s}^{-1}$ and the velocity of B is $(2\mathbf{i} - 5\mathbf{j})\,\text{m s}^{-1}$. After the collision, the velocity of A is $8\mathbf{i}\,\text{m s}^{-1}$ and the velocity of B is $V\mathbf{j}\,\text{m s}^{-1}$.

(a) Find m. *(3 marks)*

(b) Find V. *(3 marks)*

January 2012

1 Two particles, A of mass 7 kg and B of mass 3 kg, are moving on a smooth horizontal plane when they collide. Just before the collision, the velocity of A is $(3\mathbf{i} + 8\mathbf{j})\,\text{m s}^{-1}$ and the velocity of B is $(6\mathbf{i} - 5\mathbf{j})\,\text{m s}^{-1}$. During the collision, the particles coalesce to form a single combined particle.

Find the velocity of the single combined particle after the collision. *(3 marks)*

June 2012

2 Two toy trains, A and B, are moving in the same direction on a straight horizontal track when they collide. As they collide, the speed of A is $4\,\text{m s}^{-1}$ and the speed of B is $3\,\text{m s}^{-1}$. Immediately after the collision, they move together with a speed of $3.8\,\text{m s}^{-1}$.

The mass of A is 2 kg. Find the mass of B. *(3 marks)*

January 2013

5 Two particles, A and B, are moving towards each other along the same straight horizontal line when they collide. Particle A has mass 5 kg and particle B has mass 4 kg. Just before the collision, the speed of A is $4\,\text{m s}^{-1}$ and the speed of B is $3\,\text{m s}^{-1}$. After the collision, the speed of A is $0.6\,\text{m s}^{-1}$ and both particles move on the same straight horizontal line.

Find the two possible speeds of B after the collision. *(6 marks)*

June 2013

1 A toy train of mass 300 grams is moving along a straight horizontal track at a speed of $2.8\,\text{m s}^{-1}$. This toy train collides with another toy train, of mass 200 grams, which is at rest on the same track. During the collision, the two trains lock together and then move together.

Find the speed of the trains immediately after the collision. *(3 marks)*