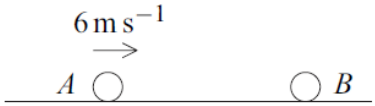
Mechanics 1 Momentum Questions

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)

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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)*

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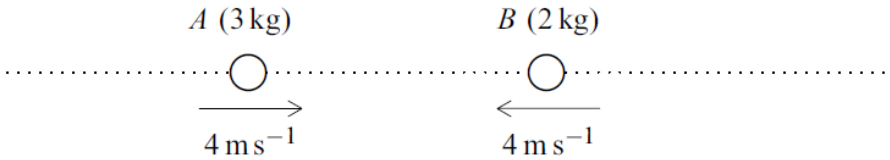
1 Two particles A and B have masses of 3 kg and 2 kg respectively. They are moving along a straight horizontal line towards each other. Each particle is moving with a speed of $4\,\text{m s}^{-1}$ when they collide.



(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)*

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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)*

Mechanics 1 Momentum Answers

1(a)	$\rightarrow 6\text{ms}^{-1}$ 2 kg ○ ○ 3 kg $\rightarrow v$			
	$2 \times 6 = 3 \times v$	M1		
	$v = 4\,\text{ms}^{-1}$	A1 A1	3	
(b)	$\rightarrow 6\text{ms}^{-1}$ 2 kg ○ ○ 3 kg $\leftarrow v$ $\rightarrow 4v$			
	$2 \times 6 = -2 \times v + 3 \times 4v$	M1		all terms
	$12 = 10v$	A1		
	$v = 1.2\,\text{ms}^{-1}$	A1√	3	√sign error $(v = 0.857)$
	Total		**6**	

8(a)	$m(5\mathbf{i} - 3\mathbf{j}) + 0.2(2\mathbf{i} + 3\mathbf{j})$	M1 A1	2	Momentum terms added All correct
(b)(i)	$(0.2 + m)(k\mathbf{i} + \mathbf{j})$	B1		Seen or used to find m
	use of conservation of momentum	M1		Used with candidate's expressions in 2D equation or used to give one of the 1D equations below
	$-3m + 0.6 = 0.2 + m$			
	$m = 0.1$	A1	3	Full verification accepted, CAO
(ii)	$5m + 0.4 = 0.2k + mk$	A1		
	substitute m	m1		
	$k = 3$	A1	3	
	Total		**8**	

1(a)	$3 \times 4 + 2 \times (-4) = 5v$	M1 A1		Three term equation for conservation of momentum. Correct equation
	$4 = 5v$			
	$v = \frac{4}{5} = 0.8$	A1	3	Correct speed (for use of mg instead of m deduct the first A1)
(b)	$3 \times 4 + 2 \times (-4) = 3 \times 0.4 + 2v$	M1 A1		Four term equation for conservation of momentum. Correct equation
	$4 = 1.2 + 2v$			
	$v = \frac{4 - 1.2}{2} = 1.4$	A1	3	Correct speed (for use of mg instead of m deduct the first A1)
			6	

2(a)	$2\begin{bmatrix}3\\-2\end{bmatrix}+3\begin{bmatrix}-4\\1\end{bmatrix}=5\mathbf{v}$	M1 A1		Three term vector equation, with a '+' sign, for conservation of momentum Correct equation Deduct this first A mark for use of *mg*
	$\mathbf{v}=\frac{1}{5}\begin{bmatrix}-6\\-1\end{bmatrix}=\begin{bmatrix}-1.2\\-0.2\end{bmatrix}$	A1	3	Correct velocity
(b)	$v=\sqrt{1.2^2+0.2^2}=1.22\ \text{ms}^{-1}$	M1 A1F	 2	Finding speed from their velocity in part (a) (Must include addition of two terms) Correct speed from their velocity Accept 1.21
	Total		**5**	