2 A particle P has mass 5 kg. It is moving along a straight line with speed 4 m s^{-1}, when it collides directly with another particle Q which is at rest. The mass of Q is m kg.

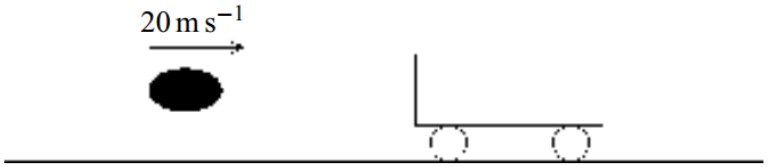
After the collision P moves with a speed of 1.2 m s^{-1} and Q moves with a speed of 1.4 m s^{-1}.

(a) If P and Q both move in the same direction after the collision, show that $m = 10$. *(3 marks)*

(b) If P and Q move in opposite directions after the collision, find m. *(3 marks)*

2(a)	$5\times4=5\times1.2+1.4m$	M1		Use of conservation of momentum to get a 3 term equation
		A1		Correct equation
	$m=\dfrac{20-6}{1.4}=10$	A1	3	**ag** correct answer from correct working
(b)	$5\times4=5\times(-1.2)+1.4m$	M1		Use of conservation of momentum to get a 3 term equation with m
	$m=\dfrac{20+6}{1.4}=18.6$	A1 A1	3	Correct equation Correct mass sc Use of mg instead of m allow M1A1 only
	Total		**6**	

3 A trolley, of mass 10 kg, is placed at rest on a set of straight horizontal rails. Large pellets, each of mass 0.5 kg, are fired at the trolley. When each pellet hits the trolley, the pellet is travelling horizontally and parallel to the rails at a speed of $20\,\text{m s}^{-1}$. When the pellets hit the trolley, they stick to it and continue to move with the trolley. Assume that there is no resistance to the motion of the trolley.

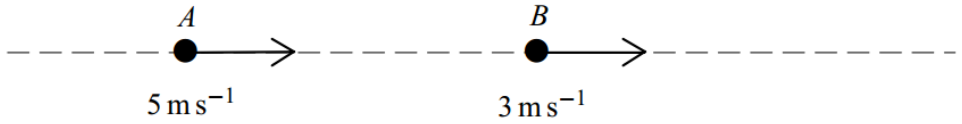


(a) Show that the speed of the trolley after it has been hit by the first pellet is $\frac{20}{21}\,\text{m s}^{-1}$. *(2 marks)*

(b) Find the speed of the trolley after it has been hit by the second pellet. *(4 marks)*

3(a)	$20\times0.5=10.5v$	M1		Conservation of momentum equation with two non-zero terms
	$v=\frac{10}{10.5}=\frac{20}{21}\,\text{ms}^{-1}$	A1	2	Correct answer from correct working
(b)	$20\times0.5+10.5\times\frac{20}{21}=11v$	M1		Conservation of momentum equation with three non-zero terms
		A1		Correct equation
	$v=\frac{20}{11}=1.82\,\text{ms}^{-1}$	M1		Solving for v
		A1	4	Correct answer
	Total		**6**	

2 Two particles, A and B, are moving with constant speeds in the same direction along a straight horizontal line. The velocity of A is $5\,\text{m s}^{-1}$ and its mass is 0.1 kg. The velocity of B is $3\,\text{m s}^{-1}$ and its mass is 0.4 kg. The two particles collide. The diagram shows the velocities before the collision.



(a) If the particles coalesce during the collision, find the velocity of the combined particle after the collision. *(3 marks)*

(b) If the particles do **not** coalesce during the collision, and the velocity of B increases to $3.5\,\text{m s}^{-1}$, find the velocity of A after the collision. *(4 marks)*

2(a)	$0.1\times5+0.4\times3=0.5v$	M1		Using conservation of momentum
		A1		Correct equation
	$v=\frac{1.7}{0.5}=3.4\,\text{ms}^{-1}$	A1	3	Correct v
(b)	$0.1\times5+0.4\times3=0.1v+0.4\times3.5$	M1		Using conservation of momentum
		A1		Correct equation
		m1		Solving for v
	$v=\frac{1.7-1.4}{0.1}=3\,\text{ms}^{-1}$	A1	4	Correct v
	Total		**7**	

1 A particle of mass m has velocity $\begin{bmatrix} 4 \\ 2 \end{bmatrix}$ m s^{-1}. It then collides with a particle of mass 3 kg which has velocity $\begin{bmatrix} -1 \\ -1 \end{bmatrix}$ m s^{-1}. During the collision the particles coalesce and move with velocity $\begin{bmatrix} 1 \\ V \end{bmatrix}$ m s^{-1}.

(a) Show that $m = 2$. *(4 marks)*

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

Q	Solution	Marks	Total	Comments
1(a)	$m\begin{bmatrix} 4 \\ 2 \end{bmatrix} + 3\begin{bmatrix} -1 \\ -1 \end{bmatrix} = (m+3)\begin{bmatrix} 1 \\ V \end{bmatrix}$	M1		M1: Conservation of momentum equation with 3 terms
	$4m - 3 = m + 3$ **AG**	A1		A1: Correct momentum equation
	$3m = 6$	M1		M1: Solving equation
	$m = 2$	A1	4	A1: Correct m from correct working Note: Deduct one mark for using mg instead of m
(b)	$4 - 3 = 5V$	M1		M1: Conservation of momentum equation for component containing V
		A1		A1: Correct equation
	$V = 0.2$	A1	3	A1: Correct V
	Total		**7**	