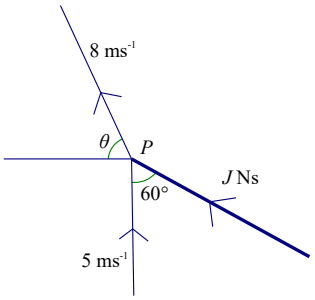
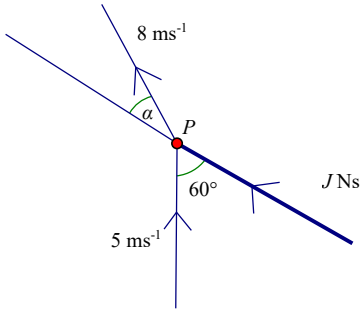
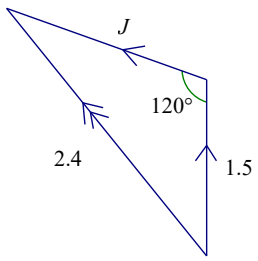
4			Resolving parallel and perpendicular to the original direction of motion
	Use of $J = m(v-u)$	M1	Use of $J = m(v-u)$ parallel or perpendicular to original direction
	$J\cos 30° = 2.4\cos\theta$ or $J\cos 60° = 2.4\sin\theta - 1.5$	A1	One correct unsimplified equation
	Use of $J = m(v-u)$	M1	Use of $J = m(v-u)$ to form second equation
		A1	2nd correct unsimplified equation
	The first 4 marks are available for a correct equation in vector form.		$\begin{pmatrix} -2.4\cos\theta \\ 2.4\sin\theta \end{pmatrix} = \begin{pmatrix} -J\cos 30° \\ J\cos 60° + 1.5 \end{pmatrix}$
	$2.4^2 = \frac{3J^2}{4} + \frac{J^2}{4} + 1.5J + 1.5^2$ $\left(J^2 + 1.5J - 3.51 = 0\right)$	DM 1	Form an equation in J only Dependent on previous two M1 marks
	$J = 1.3$	A1	1.3 or better (1.268….)
		(6)	
	NB Use of initial velocity parallel to final velocity or final velocity parallel to impulse is a method error, not a misread		
			See over for alternatives

4 Alt 1			Resolving parallel and perpendicular to the direction of the impulse.
	Use of $J = m(v-u)$	M1	Use of $J = m(v-u)$ in any direction
	$J = 0.3(8\cos\alpha - 5\cos 60°)$ Or $5\sin 60° = 8\sin\alpha$	A1	Correct unsimplified equation $\begin{pmatrix} 2.4\cos\alpha = J + 1.5\cos 60° \\ 2.4\sin\alpha = 1.5\sin 60° \end{pmatrix}$
	Use of $J = m(v-u)$	M1	Use of $J = m(v-u)$ in perpendicular direction
		A1	Correct unsimplified equation
	$2.4^2 = \left(J + \frac{3}{4}\right)^2 + \left(\frac{3}{2}\right)^2 \times \frac{3}{4}$ $\left(J^2 + 1.5J - 3.51 = 0\right)$	DM 1	Form an equation in J only Dependent on previous two M1 marks
	$J = 1.3$	A1	1.3 or better (1.268….)
	Could have a mixture of the first 2 alternatives. M1A1M1A1 for 2 independent equations. DM1A1 for solving		
		(6)	
4 Alt 2			Using vector triangle.
	Impulse momentum triangle	M1	Form dimensionally correct vector triangle (for impulse or momentum)
	Use of cosine rule	M1	Use of cosine rule in momentum or velocity triangle
	$2.4^2 = J^2 + 1.5^2 - 3J\cos 120°$	A1 A1	unsimplified equation in v or mv with at most one error Correct unsimplified equation
	$J^2 + 1.5J - 3.51 = 0$	DM 1	Form a simplified equation in J Dependent on previous two M1 marks
	$J = 1.3$	A1	1.3 or better (1.268….)
		(6)	
		[6]	