Q	Scheme	Marks	Notes
1(a)	Expression for total KE before collision	M1	Dimensionally correct. Condone confusion between before and after for A . Allow if vectors seen in the working but the modulus is used correctly. The two parts must be added together Allow confusion of 2 kg and 3 kg
	$\frac{1}{2}\times 2\times 5^2+\frac{1}{2}\times 3\times(3^2+(-1)^2)$	A1	correct unsimplified expression
	= 40 (J)	A1	cao
		(3)	
1(b)	$2((3\mathbf{i}+2\mathbf{j})-5\mathbf{j})$	M1	change in momentum of A, must be a difference but allow subtraction in either order Must be using the correct mass, 2 kg
	$=(6\mathbf{i}-6\mathbf{j})$ (N s)	A1	Cao The final answer should be in terms of **i** and **j** because this is asked for in the question. Accept 2(3**i** – 3**j**) ISW
		(2)	
1(c)	impulse-momentum equation for B	M1	must use negative of their answer to (b) and the initial velocity of B Must be using the correct mass, 3 kg or CLM with correct terms (allow slip) and plus signs
	$3(\mathbf{v}_B-(3\mathbf{i}-\mathbf{j}))=(-6\mathbf{i}+6\mathbf{j})$ or $2\times 5\mathbf{j}+3(3\mathbf{i}-\mathbf{j})=2(3\mathbf{i}+2\mathbf{j})+3\mathbf{v}_B$	A1ft	correct unsimplified equation ft on their impulse from (b)
	$\mathbf{v}_B=(\mathbf{i}+\mathbf{j})$ (m s^{-1})	A1	Cao Accept column vector ISW
		(3)	
		(8)	

Q	Scheme	Marks	Notes
2(a)	$\frac{3}{4}t = \sqrt{2t+1}$	M1	Equate the two expressions Allow M1 only if they verify that it works for $k = 4$
	$9t^2 - 32t - 16 = 0$	A1	Correct 3 term quadratic In t or in k. Any equivalent form without the root
	$t = 4$ or $-\frac{4}{9}$, so $k = 4$ $k \geqslant 0$ *	A1*	**Given answer** for k correctly explained The Q asks for an explanation, so they must explain why they reject the negative root.
		(3)	
2(b)	Differentiate v to obtain a	M1	power decreasing by 1, condone incorrect chain rule
	$a = \frac{\mathrm{d}v}{\mathrm{d}t} = \frac{1}{2}(2t+1)^{-\frac{1}{2}} \times 2$	A1	Correct derivative (any equivalent form)
	When $t = 1.5$, $a = 0.5$ ($\mathrm{m\,s^{-2}}$)	A1	cao
		SC	Allow M1A1A0 for correct differentiation seen as part of a vector approach
		(3)	
2(c)	$x = \int \sqrt{2t+1}\ \mathrm{d}t$	M1	Attempt to integrate: power increasing by 1 Must see working – the question excludes calculators for this step
	$= \frac{2}{3}(2t+1)^{\frac{3}{2}} \times \frac{1}{2}$ $(+C)$	A1	Correct indefinite integral
	Correct use of correct limits	M1	Use of $t = 0$, $x = 0$ and $t = 4$ as limits in a definite integral or to obtain the constant of integration and hence x when $t = 4$ $\left(C = -\frac{1}{3}\right)$ "Correct use" means (value when 4 substituted) – (value when 0 substituted)
	$x = \frac{26}{3}$	A1	Accept 8.7 or better
	$\int \frac{3}{4}t\ \mathrm{d}t$	M1	Attempt to integrate: power increasing by 1 Must see working – the question excludes calculators for this step NB It is correct to use *suvat* in place of this second interval, but if they do then M1 includes use of the correct initial speed (3 $\mathrm{ms^{-1}}$)
	$= \left[\frac{3}{8}t^2\right]_4^8$	A1	Correct definite integral. Accept $\frac{3\times 64}{8} - \frac{3\times 16}{8}$ or equivalent unsimplified expression
	Total = $\frac{80}{3}$ (m) (=18 (m))	A1	Accept 27 or better $\left(26.\dot{6}\right)$
		SC	Correct integration seen as part of a vector approach can score M1A1M0A0M1A0A0
		(7)	
		(13)	