Question Number	Scheme	Marks
	Allow working in column vectors and penalise answers to (a) and (b) in column vector form ONCE at the first time it occurs.	
8(a)	$\mathbf{v} = \dfrac{(9\mathbf{i}+23\mathbf{j})-(-2\mathbf{i}+\mathbf{j})}{11}$	M1
	Expression for $\mathbf{r}$ with correct structure	M1
	$\mathbf{r} = (-2\mathbf{i}+\mathbf{j})+t(\mathbf{i}+2\mathbf{j})$ or $\mathbf{r} = (t-2)\mathbf{i}+(2t+1)\mathbf{j}$	A1 cao
		(3)
8(b)	$\mathbf{s} = (25\mathbf{i}+25\mathbf{j})+t(-\mathbf{i}-\mathbf{j})$ **Or** $\mathbf{s} = (25-t)\mathbf{i}+(25-t)\mathbf{j}$	B1
		(1)
8(c)	**Either** $\mathbf{r}-\mathbf{s}$ **Or** $\mathbf{s}-\mathbf{r}$ with their $\mathbf{r}$ and $\mathbf{s}$ substituted	M1
	$\overrightarrow{SR} = \left[(2t-27)\mathbf{i}+(3t-24)\mathbf{j}\right]$m *	A1*
		(2)
8(d)	Distance $(d) = \sqrt{(2t-27)^2+(3t-24)^2}$ $(d^2) = (2t-27)^2+(3t-24)^2$	M1
	$(d^2) = 13t^2-252t+1305$	A1
	$t = \dfrac{126}{13} = 9.7$ (s) or better	A1
		(3)
		(9)

Notes for Question 8

(a)	
M1	Use of displacement/time to find velocity. Allow the difference either way round.
M1	Expression for $\mathbf{r}$ with correct structure using *their* $\mathbf{v}$ and the correct initial position vector.
A1	Correct expression in terms of t, $\mathbf{i}$ and $\mathbf{j}$
(b)	
B1	Any correct expression for $\mathbf{s}$ in terms of t, $\mathbf{i}$ and $\mathbf{j}$
(c)	
M1	(Their $\mathbf{r}$ – their $\mathbf{s}$) or vice versa, unsimplified
A1*	Correct answer correctly obtained. Allow missing square brackets and m, but rest must be identical to given answer.
(d)	
M1	Use of Pythagoras to find an expression for distance (or distance squared)
A1	Correct 3 term quadratic expression **N.B.** If no 3 term quadratic expression is seen but a correct derivative is, award this mark.
A1	9.7 or better. **N.B.** If a fraction is given as the answer, it must be the ratio of two positive integers or a mixed fraction.

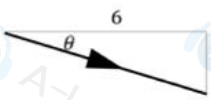
Alt (c)	$M(A)$: $15gAY + 6g \times 2 = 1.5 \times 21g$	M1	Requires all terms present and of the correct structure. No additional terms
		A2	Correct unsimplified equation -1 each error
	$AY = 1.3$ m	A1	
		(4)	
Alt (c)	$M(C)$: $6g \times 0.5 = 15g(1.5 - AY)$	M1	
		A2	-1 each error
	$AY = 1.3$ m	A1	
		(4)	
7.	$(2\mathbf{i} + 9\mathbf{j}) - (-3\mathbf{i} - 3\mathbf{j})$	M1	Use of $\mathbf{v} - \mathbf{u} (= \mathbf{a}t)$ seen or implied
	$= (5\mathbf{i} + 12\mathbf{j})$	A1	
	$k^2(5^2 + 12^2) = 2.6^2 \quad (k = 1/t)$	M1	Use magnitude = 2.6 = $k\lvert\mathbf{a}\rvert$ (linking 2.6 & 13)
	$c = 5\text{x}0.2 = 1$	A1	
	$d = 12\text{x}0.2 = 2.4$	A1	
		(5)	

Question Number	Scheme	Marks
2. (a)	$v = \sqrt{2^2 + (-3)^2} = \sqrt{13} = 3.61 \text{ ms}^{-1}$	M1 A1 (2)
(b)	$\mathbf{a} + 4(2\mathbf{i} - 3\mathbf{j}) = (\mathbf{i} - 4\mathbf{j})$ $\mathbf{a} = (-7\mathbf{i} + 8\mathbf{j})$ m	M1 A1 DM1 A1 (4) **6**

Notes	
2. (a)	M1 for $\sqrt{}$ (sum of squares of cpt.s) allow $\sqrt{(2^2+3^2)}$ A1 for $\sqrt{13}$, 3.6 or better
(b)	First M1 for $\mathbf{a} \pm 4(2\mathbf{i} - 3\mathbf{j}) = (\mathbf{i} - 4\mathbf{j})$ oe A1 for $\mathbf{a} + 4(2\mathbf{i} - 3\mathbf{j}) = (\mathbf{i} - 4\mathbf{j})$ oe Second DM1, dependent, for solving for a A1 for $(-7\mathbf{i} + 8\mathbf{j})$ A0 for $\begin{pmatrix} -7\mathbf{i} \\ 8\mathbf{j} \end{pmatrix}$ or $(-7\mathbf{i}, 8\mathbf{j})$

	Allow column vectors throughout apart from in the answers to (b) and (c).		
7a	$\lvert\mathbf{a}\rvert = \sqrt{1^2+(-4)^2}$ or $\sqrt{1^2+4^2}$	M1	Complete method to find the magnitude using the correct vector or the correct vector with just a sign error. They may use $\mathbf{a} = \frac{\mathbf{v}_p - \mathbf{v}_q}{p-q}$ for two specific times p and q, allow subtraction either way round and slips in arithmetic
	$= \sqrt{17}$. Accept $4.1\left(\text{km h}^{-2}\right)$ or better	A1	$= 4.123105\ldots\ \left(\text{km h}^{-2}\right)$ Must come from a correct **a** (if seen.)
		(2)	
7b	$\frac{(\mathbf{i}-5\mathbf{j})-(4\mathbf{i}+\mathbf{j})}{3}$	M1	Condone subtraction the wrong way round
	$= -\mathbf{i}-2\mathbf{j}\quad\left(\text{km h}^{-2}\right)$	A1	Must be in **i** and **j**
		(2)	
7c	$4\mathbf{i}+\mathbf{j}-2(-\mathbf{i}-2\mathbf{j})$ **OR** $\mathbf{i}-5\mathbf{j}-5(-\mathbf{i}-2\mathbf{j})$	M1	Or equivalent for their **a**
	$= 6\mathbf{i}+5\mathbf{j}\quad\left(\text{km h}^{-1}\right)$	A1	Must be in **i** and **j**. Isw if they find the speed.
			N.B. In (b) and (c), penalise the use of column vectors in the answers ONCE.
		(2)	
7d	Express both velocities in component form, with **i**'s and **j**'s collected, using their answers to (b) and (c) for $\mathbf{v}_B$.	M1	$\mathbf{v}_A = (2+t)\mathbf{i}+(3-4t)\mathbf{j}$ $\mathbf{v}_B = (6-t)\mathbf{i}+(5-2t)\mathbf{j}$ Seen or implied. Allow slips. **N.B.** This mark can be earned in part (e).
	Correct use of Pythagoras to form an equation in T_1 (or t) only, with or without square roots.	M1	For given $\mathbf{v}_A$ and their $\mathbf{v}_B$
	$(6-T_1)^2+(5-2T_1)^2 = (2+T_1)^2+(3-4T_1)^2$ $\left(T_1^2+T_1-4=0\right)$	A1**ft**	Correct unsimplified equation in T_1 (or t), without square roots. Follow their answers from (b) and (c)
	$\frac{-1+\sqrt{17}}{2}$ only	A1	cao accept exact equivalent
		(4)	
7e	Use ratios to form an equation in T_2 (or t) only	M1	Allow reciprocal on one side **N.B**. Allow if **i**'s and **j**'s are left in

	$\Rightarrow \frac{5-2T_2}{6-T_2} = \frac{3-4T_2}{2+T_2}$ (allow t at this stage)	A1**ft**	Or equivalent ft on their $\mathbf{v_B}$
	$\Rightarrow 3T_2^2 - 14T_2 + 4 = 0$ *	A1*	Obtain **correct answer** from full and correct working with no errors. Must see at least $10 + 5T_2 - 4T_2 - 2T_2^2 = 18 - 24T_2 - 3T_2 + 4T_2^2$ **OR** $10 + T_2 - 2T_2^2 = 18 - 27T_2 + 4T_2^2$ (Allow t at this stage but must be T_2 in final answer) $\Rightarrow 3T_2^2 - 14T_2 + 4 = 0$ *
		(3)	
		(13)	

Question Number	Scheme	Marks
3(a)	$\text{Velocity} = (14\mathbf{i} - 5\mathbf{j}) + 2(-4\mathbf{i} + \mathbf{j})$	M1
	$\text{Speed} = \sqrt{6^2 + (-3)^2}$	M1
	$\text{Speed} = \sqrt{45} = 3\sqrt{5} = 6.7\left(\text{ms}^{-1}\right)$ or better	A1 cso
		(3)
3(b)	 $\tan^{-1}\left(\frac{3}{6}\right)$	M1 A1ft
	27° or better **OR** 333° or better 0.46 rads or better **OR** 5.8 rads or better	A1
		(3)
3(c)	$\mathbf{v} = (14\mathbf{i} - 5\mathbf{j}) + (-4\mathbf{i} + \mathbf{j})T$ (allow t) **OR** $\mathbf{v} = (6\mathbf{i} - 3\mathbf{j}) + (-4\mathbf{i} + \mathbf{j})t$ $(t = T - 2)$	M1
	$\frac{14 - 4T}{-5 + T} = \frac{2}{-3}$	M1 A1
	$T = 3.2$	A1
		(4)
(10)		

	NOTES	
	Accept the use of column vectors throughout	
(a)		
M1	Correct use of $t = 2$ to find the velocity (unsimplified).	
M1	Use of Pythagoras to find the speed when $t = 2$ with <u>their</u> velocity.	
A1	$\sqrt{45} = 3\sqrt{5} = 6.7\left(\text{ms}^{-1}\right)$ or better (6.70820…). Must come from correct velocity.	
(b)		
M1	Use trig to find an equation in a relevant angle e.g. $(90° - \theta)$ for their *velocity*.	
A1ft	Correct equation for a relevant angle, ft on their **v**	
A1	Cao. No isw (A0 for a negative answer)	

(c) **M1** **M1** **A1** **A1**	Use of $\mathbf{v} = \mathbf{u} + \mathbf{a}T$ to obtain a velocity vector in T (allow t) Use ratios, using *their* **velocity**, to produce an equation in T only (Allow reciprocal and incorrect sign) Correct equation in T only Cao **N.B.** If they use their answer to (a) instead of $\mathbf{u} = (14\mathbf{i} - 5\mathbf{j})$ but never correct their value of t, can score M1M1A0A0 **N.B.** If they use $\mathbf{v} = k(2\mathbf{i} - 3\mathbf{j})$ to produce 2 simultaneous equations in k and T, and then they use a calculator to solve and get $T = 3.2$, award all the marks, but if they get the wrong answer, they lose the last 3 marks.	