Question number	Scheme	Marks
4	Accept column vectors throughout the question	
4(a)	Solves at least one of • $14+6t-25\sqrt{t}=0$ • $7+8t-30\sqrt{t}=0$	M1
	Find $t=\frac{49}{4}$ from at least one equation	A1
	Both equations used to conclude $t=\frac{49}{4}$ only	A1
		(3)
4(b)	Differentiates both components	M1
	$\mathbf{a}=\left(6-\frac{25}{2}t^{-\frac{1}{2}}\right)\mathbf{i}+\left(8-15t^{-\frac{1}{2}}\right)\mathbf{j}$	A1
	Use of components to form a relevant equation in t. Scalar product gives: $\begin{pmatrix}6-\frac{25}{2}t^{-\frac{1}{2}}\\8-15t^{-\frac{1}{2}}\end{pmatrix}\bullet\begin{pmatrix}2\\-1\end{pmatrix}=0$ $\Rightarrow \quad 2\left(6-\frac{25}{2}t^{-\frac{1}{2}}\right)-\left(8-15t^{-\frac{1}{2}}\right)=0$	M1
	$t=6.25$	A1
		(4)
4(c)	Integrates both components	M1
	$\mathbf{s}=\left(14t+3t^2-\frac{50}{3}t^{\frac{3}{2}}\right)\mathbf{i}+\left(7t+4t^2-20t^{\frac{3}{2}}\right)\mathbf{j}$ (+ constant vector)	A1
	Use $t=1$ and $\mathbf{s}=\frac{1}{3}\mathbf{i}-7\mathbf{j}$ to find	M1
	$\mathbf{s}=\left(14t+3t^2-\frac{50}{3}t^{\frac{3}{2}}\right)\mathbf{i}+\left(7t+4t^2-20t^{\frac{3}{2}}+2\right)\mathbf{j}$	A1
	Complete method to find OP $\sqrt{\left(14(4)+3(4)^2-\frac{50}{3}(4)^{\frac{3}{2}}\right)^2+\left(7(4)+4(4)^2-20(4)^{\frac{3}{2}}+2\right)^2}$	M1
	$OP=72$ or better	A1
		(6)

(c) ALT 1	Last 4 marks in (c) using definite integration	
	Use of correct limits in integrated expression to find displacement, $1 \leqslant t \leqslant 4$ $\left[\left(14t+3t^2-\frac{50}{3}t^{\frac{3}{2}}\right)\mathbf{i}+\left(7t+4t^2-20t^{\frac{3}{2}}\right)\mathbf{j}\right]_1^4=-\frac{89}{3}\mathbf{i}-59\mathbf{j}$	M1 A1
	Complete method to find OP $OP=\sqrt{\left(-\frac{88}{3}\right)^2+(-66)^2}$	M1
	$OP = 72$ or better	A1
		(6)
		(13)
	Notes for question	
(a)		
M1	Solves for t or $\sqrt{t}$ in either **i** or **j** component equal to zero.	
A1	Find $t=\frac{49}{4}$ from at least one equation. Using i components: $t=\frac{49}{4}\left(\text{and } \frac{4}{9}\right)$ or Using j components, $t=\frac{49}{4}\left(\text{and } \frac{1}{16}\right)$ **N.B. Equating components is M0** **Adding components and equating to 0 is M0**	
A1	Uses both equations to conclude $t=\frac{49}{4}$ **(only).** May solve both equations or solve one and using verification.	
	Special case	
	Find magnitude of vector **and** equate to zero **and** solve for t	M1
	Find $t=\frac{49}{4}$ as one possible solution	A1
	For final A mark must obtain correct value of t and dismiss other cases. Equation $100P^4-780P^3+1805P^2-1120P+245=0$ Where $P=\sqrt{t} \Rightarrow P=\frac{7}{2}, t=\frac{49}{4}$	A1

(b)		
M1	Differentiates both components of **v**. In each component, at least one power must decrease by 1.	
A1	Correct expression for acceleration, seen or implied.	
M1	Use the components of acceleration to form a relevant equation in t only. May use the parallel vector $\mathbf{i}+2\mathbf{j}$ to form an equation in t only. For example, $\dfrac{\left(6-\frac{25}{2}t^{-\frac{1}{2}}\right)}{8-15t^{-\frac{1}{2}}}=\dfrac{1}{2}$ or $\left(6-\frac{25}{2}t^{-\frac{1}{2}}\right)\mathbf{i}+\left(8-15t^{-\frac{1}{2}}\right)\mathbf{j}=\lambda(\mathbf{i}+2\mathbf{j})$ to form simultaneous equations with λ eliminated. Must be correct ratio M0 if using $-\frac{1}{2}, \frac{2}{1}$ or $\lambda(\mathbf{i}-2\mathbf{j})$	
A1	Correct answer, accept 6.3	
(c)		
M1	Integrates both components of **v**. In each component, at least one power must increase by 1.	
A1	Correct unsimplified expression. Allow with no constant(s) of integration.	
M1	Use $t = 1$ and $s=\frac{1}{3}\mathbf{i}-7\mathbf{j}$, to find an expression for position.	
A1	Correct expression for position at time, t.	
M1	Use $t = 4$ and Pythagoras to find the distance OP. Must use an expression that has come from an attempt to **integrate v** **M0 if they find** $\sqrt{\left(-\frac{89}{3}\right)^2+59^2}$	
A1	Correct answer, accept 72 or better 72.2249.., Accept $\dfrac{22\sqrt{97}}{3}$	