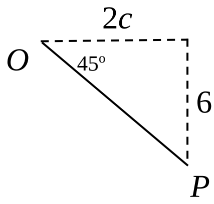
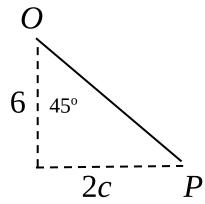
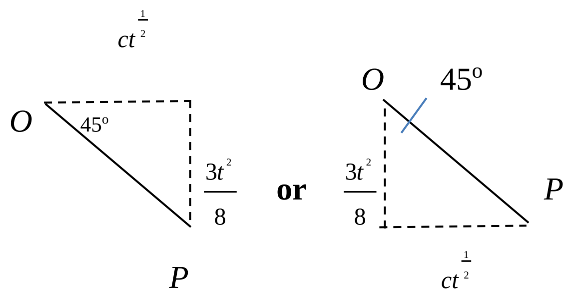
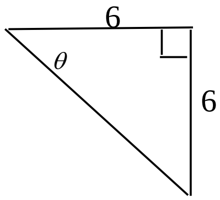
Question	Scheme	Marks	AOs
4(a)	**ALTERNATIVES** when $t = 4$ is substituted at the beginning.		
	$2c\mathbf{i} - 6\mathbf{j}$ or as a column vector, seen or implied.	B1	1.1b
	ALT 1  **or**  **AND** **either** $\tan 45^o = \frac{2c}{6}$ => $2c = 6$ **or** **states** isosceles triangle so $2c = 6$ **N.B.** In both of the above,we must see the justification for the equation. **ALT 2** $\tan 135^o = \frac{2c}{-6}$ => $2c = 6$ **N.B.** M0 if they are using the wrong bearing.	M1	3.1a
	$c = 3$ *	A1*	2.2a
	SC 1 M1A0: no right-angled triangle $2c\mathbf{i} - 6\mathbf{j} = k(\mathbf{i} - \mathbf{j})$ => $2c = 6$ **or** **i**-cpt **=** – **j**-cpt => $2c = 6$ **N.B.** In both of the above,we must see the justification for the equation. **SC 2 M1A0:** no right-angled triangle $\tan 45^o = \frac{2c}{6}$ or $\frac{6}{2c}$ => $2c = 6$ **N.B.** In the above,we must see the justification for the equation.		

	ALTERNATIVES when t = 4 is substituted at the end:		
	$ct^{\frac{1}{2}} = 2c$ **and** $(-)\frac{3t^2}{8} = (-)6$ when t = 4, seen or implied	B1	
	ALT 3  **AND** **either** $\tan 45^o = \frac{\frac{3t^2}{8}}{ct^{\frac{1}{2}}}$ => $2c = 6$ when $t = 4$ **or** **states** isosceles triangle, so $ct^{\frac{1}{2}} = \frac{3t^2}{8}$ => $2c = 6$ when $t = 4$ **N.B.** In both of the above,we must see the justification for the equation. **N.B.** M0 if they are using the wrong bearing.	M1	
	c = 3	A1*	
	SC 3 M1A0: no right-angled triangle $(ct^{\frac{1}{2}}\mathbf{i} - \frac{3t^2}{8}\mathbf{j}) = k(\mathbf{i} - \mathbf{j})$ => $2c = 6$ when $t = 4$ **or** **i**-cpt **=** – **j**-cpt => $ct^{\frac{1}{2}} = \frac{3t^2}{8}$ => $2c = 6$ when $t = 4$ **N.B.** In both of the above,we must see the justification for the equation. **SC 4 M1A0:** no right-angled triangle $\tan 45^o = \frac{\frac{3t^2}{8}}{ct^{\frac{1}{2}}}$ => $2c = 6$ when $t = 4$.		

	N.B. Allow a **verification**: i.e. use $c = 3$ and $t = 4$ to show that P is on a bearing of 135° from O. $6\mathbf{i} - 6\mathbf{j}$ then a diagram:  **AND** $\tan\theta = \frac{6}{6}$ or isosceles triangle => $\theta = 45^{\circ}$ **N.B.** In the above,we must see the justification for the equation.	B1 M1	
	bearing = $45^{\circ} + 90^{\circ} = 135^{\circ}$	A1*	
		(3)	
4(b)	Differentiate **r** wrt t to obtain **v**	M1	2.1
	$\mathbf{v} = 3\times\frac{1}{2}t^{-\frac{1}{2}}\mathbf{i} - \frac{3}{8}\times 2t\mathbf{j} = \frac{3}{2}t^{-\frac{1}{2}}\mathbf{i} - \frac{3}{4}t\mathbf{j}$ oe	A1	1.1b
	Put $t = 4$ into **both** components and use Pythagoras: $\sqrt{\left(\frac{3}{4}\right)^2 + (-3)^2}$	M1	3.1a
	$\sqrt{\frac{153}{16}}$ or $\frac{\sqrt{153}}{4}$ or $\frac{3\sqrt{17}}{4}$ or $3\sqrt{\frac{17}{16}} = 3.0923..$ (m s^{-1})	A1	1.1b
		(4)	
4(c)	Differentiate their **v** wrt t to obtain **a**	M1	3.4
	$\mathbf{a} = -\frac{3}{4}t^{-\frac{3}{2}}\mathbf{i} - \frac{3}{4}\mathbf{j}$	A1	1.1b
	$\frac{-\frac{3}{4}T^{-\frac{3}{2}}}{-\frac{3}{4}} = \frac{-1}{-27}$ oe	M1	2.1
	$(T =)\ 9$	A1	1.1b
		(4)	

		(11 marks)
Notes: Accept column vectors throughout		
4a	B1	$2c\mathbf{i} - 6\mathbf{j}$ seen or implied. B0 for r = 2*c* – 6 if no evidence of components.
	M1	**ALT 1:** Use the bearing to obtain a CORRECT diagram showing a right-angled triangle with at least one 45° angle marked or clearly explained (i.e. 135° marked on the diagram and either $135^o - 90^o = 45^o$ or $180^o - 135^o = 45^o$), and 2*c* and ± 6 marked **AND** use of isosceles triangle or tan or (sin/cos and Pythag) to obtain 2*c* = 6 **ALT 2: No diagram required** Use $\tan 135^o = \frac{2c}{-6}$ => 2*c* = 6
	A1*	Given answer correctly obtained
		ALTERNATIVE when *t* = 4 is substituted at the end:
	B1	$ct^{\frac{1}{2}}$ = 2*c* **and** (–)$\frac{3t^2}{8}$ = (–)6 when *t* = 4, seen or implied
	M1	**ALT 3:** Use the bearing to obtain a CORRECT diagram showing a right-angled triangle with at least one 45° angle marked or clearly explained (i.e. 135° marked on the diagram and either $135^o - 90^o = 45^o$ or $180^o - 135^o = 45^o$), and $ct^{\frac{1}{2}}$ and $\pm\frac{3t^2}{8}$ marked **AND** use of isosceles triangle or tan or (sin/cos and Pythag) to obtain 2*c* = 6 when *t* = 4
	A1*	Given answer correctly obtained
4b	M1	Both powers of *t* decreasing by 1 (M0 if **i** or **j** is missing but allow recovery or working with components only) **N.B.** This mark is available if *c* has not been substituted for.
	A1	Correct unsimplified derivative or two correct components
	M1	Put *t* = 4 in their **v** (must be using an attempted derivative of **r**) and then use Pythagoras with the root, allow a missing – sign **N.B.** If they **state** *t* = 4, allow a slip when they substitute in, for this M mark. This mark is available if *c* has not been substituted for.
	A1	Accept 3.1 or better
4c	M1	Both powers of *t* decreasing by 1 **N.B.** This mark is available if *c* has not been substituted for (M0 if **i** or **j** is missing but allow recovery or working with components only).
	A1	Correct unsimplified derivative
	M1	Use of an appropriate **ratio** (must be using an attempted derivative of **their v)**, condone sign error and the **reciprocal,** to obtain an equation in *t* or ***T*** **only**. **N.B.** If they state that $-\frac{3}{4}T^{-\frac{3}{2}}\mathbf{i} - \frac{3}{4}\mathbf{j} = k(-\mathbf{i} - 27\mathbf{j})$ and then equate coefficients to give two simultaneous equations in *k* and *T*, these need to be used to produce an equation in ***T*** **only**, before the M mark is earned.
	A1	cao (allow *t* instead of *T*)