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Mark Scheme (Final)

Summer 2018

Pearson Edexcel GCE In Further Pure Mathematics FP1 (6667/01)

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6667

Mathematics FP1

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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Mathematics FP1 6667

Question Number	Scheme	Notes	Marks
1.	$f(z) = 2z^3 - 4z^2 + 15z - 13 \equiv (z - 1)$	$-1)(2z^2 + az + b)$	
(a)	a = -2, b = 13	At least one of either $a=-2$ or $b=13$ or seen as their coefficients.	B1
(11)		Both $a=-2$ and $b=13$ or seen as their coefficients.	B1
			[2]
(b)	$\{z=\}$ 1 is a root	1 is a root, seen anywhere.	B1
	$\left\{2z^2 - 2z + 13 = 0 \Rightarrow z^2 - z + \frac{13}{2} = 0\right\}$		
	Either • $z = \frac{2 \pm \sqrt{4 - 4(2)(13)}}{2(2)}$	Correct method for solving a 3-term	
	or $\left(z - \frac{1}{2}\right)^2 - \frac{1}{4} + \frac{13}{2} = 0$ and $z =$	quadratic equation. Do not allow M1 here for an attempt at factorising.	M1
	or $(2z-1)^2-1+13=0$ and $z=$		
		At least one of either	
	So, $\{z=\}$ $\frac{1}{2} + \frac{5}{2}i$, $\frac{1}{2} - \frac{5}{2}i$	$\frac{1}{2} + \frac{5}{2}i$ or $\frac{1}{2} - \frac{5}{2}i$	A1
		or any equivalent form.	
		For conjugate of first complex root	A1ft
			[4]
			Total 6

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Question Number	Scheme	Notes	Marks
2. (a)	f(-3) = 2.05555555 $f(-2.5) = -1.15833333$	Attempt both of $f(-3) = \text{awrt } 2.1 \text{ or trunc } 2 \text{ or } 2.0 \text{ or } \frac{37}{18}$ and $f(-2.5) = \text{awrt } -1.2 \text{ or trunc } -1.1 \text{ or } -\frac{139}{120}$	M1
	Sign change oe (and $f(x)$ is continuous) therefore a root α {exists in the interval $[-3, -2.5]$.}	Both $f(-3) = \text{awrt } 2.1$ and $f(-2.5) = \text{awrt } -1.2$, sign change and 'root' or ' α '. Any errors award A0.	A1 [2]
(b)	$f'(x) = 3x - \frac{4}{3x^2} + 2$	$\frac{3}{2}x^2 \to \pm Ax \text{ or } \frac{4}{3x} \to \pm Bx^{-2}$ or $2x - 5 \to 2$ Calculus must be seen for this to be awarded. At least two terms differentiated correctly Correct derivative.	M1 A1 A1
	$\alpha = -3 - \left(\frac{"2.055"}{"-7.148"}\right)$	Correct application of Newton-Raphson using their values from calculus.	M1
	$= -2.71243523 \text{ or } -\frac{1047}{386} \text{ or } -2\frac{275}{386}$	Exact value or awrt -2.712	A1
(c)	$\frac{-2.5 - \alpha}{"1.158"} = \frac{\alpha3}{"2.055"} \text{ or}$ $\frac{\alpha3}{"2.055"} = \frac{-2.53}{"2.055" + "1.158"}$	A correct linear interpolation statement $\frac{-2.5 + \alpha}{\text{with correct signs.}} = \frac{-\alpha3}{\text{"2.055"}}$ provided α sign changed at the end. Do not award until α is seen.	[5] M1
	$\alpha = -3 + \left(\frac{"2.055"}{"2.055" + "1.158"}\right) (0.5) \text{ or}$ $\alpha = -3 + \left(\frac{"2.055"}{"3.213"}\right) (0.5) \text{ or}$ $\alpha = \left(\frac{(-2.5)("2.055") - 3("1.158")}{"2.055" + "1.158"}\right)$	Achieves a correct linear interpolation statement with correct signs for $\alpha =$ dependent on the previous method mark.	dM1
	$=-2.68020743 \text{ or } -\frac{3101}{1157} \text{ or } -2\frac{787}{1157}$	-2.680: only penalise accuracy once in (b)	
	=-2.680 (3 dp)	and (c), but must be to at least 3sf.	A1 cao

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ALT (c)	The gradient of the line between (-3, 2.055) and		
	(-2.5, -1.158) is $\frac{2.0551.158}{-3-2.5} = -6.427$		
	Equation of the line joining the points $y-2.055=-6.427(x3)$	Correct attempt to find the equation of a	M1
	y-2.035=-0.427(x3)	line between the two points.	
	At $y = 0$, 0 - 2.055 = -6.427(x3)	Subs $y = 0$ in their line and achieves $x =$	dM1
	$\Rightarrow x = -2.680$	-2.680: only penalise accuracy once in (b)	A1 cao
	→ x = -2.080	and (c), but must be to at least 3sf.	ATCao
			[3]
			Total 10

Question	Scheme	Notes	Mai	rks
Number	Scheme		17141	
3. (i) (a)	$\mathbf{A}^{-1} = \frac{1}{-2 - 3} \begin{pmatrix} 1 & -3 \\ -1 & -2 \end{pmatrix}$	Either $\frac{1}{-2-3}$ or $-\frac{1}{5}$ or $\begin{pmatrix} 1 & -3 \\ -1 & -2 \end{pmatrix}$	M1	
	2 3(1 2)	Correct expression for A ⁻¹	A1	
				[2]
(b)	$\left\{\mathbf{B} = \mathbf{A}^{-1}(\mathbf{A}\mathbf{B})\right\}$			
	$\mathbf{B} = -\frac{1}{5} \begin{pmatrix} 1 & -3 \\ -1 & -2 \end{pmatrix} \begin{pmatrix} -1 & 5 & 12 \\ 3 & -5 & -1 \end{pmatrix}$	Writing down their A^{-1} multiplied by AB	M1	
	(1)(-10 20 15)	At least one correct row or at least two correct		
	$= \left\{ -\frac{1}{5} \right\} \begin{pmatrix} -10 & 20 & 15 \\ -5 & 5 & -10 \end{pmatrix}$	columns of $\left(\begin{array}{c} \dots \\ \dots \end{array} \right)$. (Ignore $-\frac{1}{5}$).	A1	
	$= \begin{pmatrix} 2 & -4 & -3 \\ 1 & -1 & 2 \end{pmatrix}$	Correct simplified matrix for B	A1	
				[3]
ALT (b)	Let $\mathbf{B} = \begin{pmatrix} a & b & c \\ d & e & f \end{pmatrix}$			
	$-2a + 3d = -1 \qquad -2b + 3e = 5$	Writes down at least 2 correct sets of		
	$a+d = 3 \qquad b+e = -5$	simultaneous equations	N/1	
	-2c + 3f = 12		M1	
	c+f=-1			
	${a=2, d=1, b=-4, e=-1, c=-3, f=2}$			
	(2 -4 -3)	At least one correct row or	A1	
	$\mathbf{B} = \begin{pmatrix} 2 & -4 & -3 \\ 1 & -1 & 2 \end{pmatrix}$	at least two correct columns for the matrix B	A 1	-
	/	Correct matrix for B	A1	[2]
(ii) (a)	Rotation	Rotation only.	M1	[3]
(11) (11)	Tourion	90° (or $\frac{\pi}{2}$) clockwise about the origin	1711	
		or 270° (or $\frac{3\pi}{2}$) (anti-clockwise) about the		
	90° clockwise about the origin	origin.	A1	
		-90° (or $-\frac{\pi}{2}$) (anticlockwise) about the		
		origin. Origin can be written as $(0,0)$ or O.		
				[2]
		For stating \mathbf{C}^{-1} or \mathbf{C}^{3} or 'rotation of 270°		
	(0 1)	clockwise o.e. about the origin.	M1	
(b)	$\left\{ \mathbf{C}^{39} \right\} = \mathbf{C}^{-1} \text{ or } \mathbf{C}^{3} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$	Can be implied by correct matrix.	 	
	(1 0)	$\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$	A1	
		Correct answer with no working award M1A1	111	
		Correct answer with no working award WITAT		[2]
			Tot	tal 9

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Question Number	Scheme	Notes	Marks
4. (a)	$\sum_{r=1}^{n} \left(r^2 - r - 8\right)$		
	$= \frac{1}{6}n(n+1)(2n+1) - \frac{1}{2}n(n+1) - 8n$	At least one of the first two terms is correct.	M1
	0 2	Correct expression	A1
	$= \frac{1}{6}n((2n+1)(n+1)-3(n+1)-48)$	An attempt to factorise out at least <i>n</i> .	M1
	$= \frac{1}{6}n(2n^2 + 3n + 1 - 3n - 3 - 48)$		
	$=\frac{1}{6}n(2n^2-50)$		
	$= \frac{1}{6}n(2n^2 + 3n + 1 - 3n - 3 - 48)$ $= \frac{1}{6}n(2n^2 - 50)$ $= \frac{2}{6}n(n^2 - 25)$ $= \frac{1}{3}n(n - 5)(n + 5)$		
	$= \frac{1}{3}n(n-5)(n+5)$	Achieves the correct answer.	A1
			[4]
(b)	n = 5	5. Give B0 for 2 or more possible values of <i>n</i> .	B1 cao
		•	[1]
		Applying at least one of $n=17$ or $n=2$ to both	
(c)	$\left(\frac{k}{4}(17^2)(18^2) - \frac{k}{4}(3^2)(2^2)\right) + \left(\frac{1}{3}(17)(22)(12) - \frac{1}{3}(2)(-3)(7)\right)$	$\frac{1}{4}n^2(n+1)^2$ and their	M1
		$\frac{1}{3}n(n-5)(n+5)$	
		Applying $n=17$ and $n=2$ only to both	
		$\frac{1}{4}n^2(n+1)^2$ and their	M1
		$\frac{1}{3}n(n-5)(n+5).$	
		Require differences only for both brackets.	
		Sets their sum to 6710	1.13.7.1
	$\{\Sigma = 6710 \Rightarrow\} 23409k - 9k + 1496 + 14 = 6710 \Rightarrow k = \frac{2}{9}$	and solves to give $k =$	ddM1
	$\frac{1}{2}$ = 0/10 $\frac{1}{2}$ / 2540/k = $\frac{1}{2}$ / 1470 $\frac{1}{2}$ / 14 = 0/10 $\frac{1}{2}$ / $\frac{1}{9}$	$k = \frac{2}{9} \text{ or } 0.\dot{2}$	A1 cso
			[4]
			Total 9

$\begin{array}{c} \mathbf{S}. \text{ (a)} \\ \mathbf{y} = c^2 x^{-1} \Rightarrow \frac{\mathrm{dy}}{\mathrm{dx}} = -c^2 x^{-2} \\ \text{or (implicitly)} \ \mathbf{y} + \frac{\mathrm{dy}}{\mathrm{dx}} = 0 \\ \text{or (chain rule)} \ \frac{\mathrm{dy}}{\mathrm{dx}} = -c r^2 \times \frac{1}{c} \\ \text{When } x = ct, \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = -\frac{c^2}{c^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = -\frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = \frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = \frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = \frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = \frac{1}{t^2} \\ \text{or at } P\left(ct, \frac{c}{t}\right), \ m_r = \frac{\mathrm{dy}}{\mathrm{dx}} = \frac{-c^2}{x^2} = \frac{1}{t^2} \\ o$	Question Number	Scheme	Notes	Marks
or (implicitly) $y + x \frac{dy}{dx} = 0$ or (chain rule) $\frac{dy}{dx} = -cr^2 \times \frac{1}{c}$ When $x = ct$, $m_r = \frac{dy}{dx} = \frac{-c^2}{(ct)^2} = -\frac{1}{t^2}$ or at $P\left(ct, \frac{c}{t}\right)$, $m_r = \frac{dy}{dx} = -\frac{ct^3}{x} = -\frac{t^3}{ct}$ T: $y - \frac{c}{t} = -\frac{1}{t^2}(x - ct)$ Applies $y - \frac{c}{t} = (\text{heir } m_r)(x - ct)$ where their m_r has come from calculus T: $t^2y - ct = -x + ct$ At least one line of working. T: $t^2y - ct = -x + ct$ T: $t^2y + x = 2ct$ Substitutes $\left(-\frac{8c}{5}, \frac{3c}{5}\right)$ into tangent. Al correct solution. Al cos * [4] Al. T: $t^2 - t = -x + ct$ Substitutes $\left(-\frac{8c}{5}, \frac{3c}{5}\right)$ into tangent. Al condition and a swapped or missing. Al. T: $t = 4$, $t = \frac{2}{3}$ and $t = 4$, $t = \frac{2}{3}$ and $t = \frac{8c}{5}$ and $t = 8c$		dy a a	dy ,	
$ \text{or } (\text{chain rule}) \frac{dy}{dx} = -ct^2 \times \frac{1}{c} \qquad \qquad \text{or } \frac{dx}{\text{their } \frac{dx}{dx}} $ $ \text{When } x = ct, m_r = \frac{dy}{dx} = -\frac{c^2}{ct^2} = -\frac{1}{t^2} $ $ \text{or at } P(ct, \frac{c}{t}), m_r = \frac{dy}{dx} = -\frac{y}{x} = -\frac{ct^2}{ct} = -\frac{1}{t^2} $ $ \text{Applies } y - \frac{c}{t} = (\text{their } m_r)(x - ct) $ $ \text{where their } m_r \text{ has come from calculus} $ $ \text{T: } t^2y - ct = -x + ct $ $ \text{At least one line of working.} $ $ \text{T: } t^2y + x = 2ct * $ $ \text{Correct Solution.} \text{A1 } \cos * $ $ \text{[4]} $ $ \text{Substitutes} \left(-\frac{8c}{5}, \frac{3c}{5} \right) \text{ into tangent.} $ $ \text{M1} $ $ \text{A2} \text{Correct } 3\text{TQ in terms of } t $ $ \text{Correct oordinates.} $ $ \text{A3} \text{Condone A and } B \text{ swapped or missing.} $ $ \text{[5]} $ $ \text{Total 9} $ $ \text{ALT 1} \text{(b)} y - \frac{3c}{5} = -\frac{1}{t^2}(x - \frac{8c}{5}) $ $ \text{Substitutes} \left(-\frac{8c}{5}, \frac{3c}{5} \right) \text{ into tangent.} $ $ \text{M1} $ $ \text{Correct 3TQ in terms of } t $ $ \text{Condone A and } B \text{ swapped or missing.} $ $ \text{[5]} $ $ \text{Total 9} $ $ \text{ALT 1} \text{(b)} y - \frac{3c}{5} = -\frac{1}{t^2}(x - \frac{8c}{5}) $ $ \text{Substitutes} \left(ct, \frac{c}{t} \right) \text{ into their } t $ $ \text{Correct 3TQ in terms of } t . $ $ \text{Correct 3TQ in terms of } t . $ $ \text{Condone A and } B \text{ swapped or missing.} $ $ \text{[5]} $ $ \text{Total 9} $ $ \text{ALT 1} \text{(b)} y - \frac{3c}{5} = -\frac{1}{t^2}(ct + \frac{8c}{5}) $ $ \text{Substitutes} \left(ct, \frac{c}{t} \right) \text{ into their } t . $ $ \text{Correct 3TQ in terms of } t . $ $ \text{Can include uncancelled } c . $ $ \text{Al } 1 $ $ \text{Correct 3TQ in terms of } t . $ $ \text{Can include uncancelled } c . $ $ \text{Al } 1 $ $ \text{ALT 1} t_1, t_2 = \frac{10}{3}, t_1 t_2 = \frac{8}{3} $ $ \text{Correct 3TQ in terms of } t_1 \text{ or } t_2 $ $ \text{Can include uncancelled } c . $ $ \text{Correct 3TQ in terms of } t_1 \text{ or } t_2 $ $ \text{Can include uncancelled } c . $ $ \text{Correct 3TQ in terms of } t_1 \text{ or } t_2 $ $ \text{Can include uncancelled } c . $ $ \text{Correct 3TQ in terms of } t_1 \text{ or } t_2 $ $ \text{Can include uncancelled } c . $		$y = c^2 x^{-1} \Rightarrow \frac{dy}{dx} = -c^2 x^{-2}$	$\frac{1}{dx} = \pm k x$	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		or (implicitly) $y + x \frac{dy}{dx} = 0$	or $y + x \frac{dy}{dx} = 0$	M1
or at $P\left(ct,\frac{c}{t}\right)$, $m_r = \frac{dy}{dx} = -\frac{y}{x} = \frac{ct^{-1}}{ct} = -\frac{1}{t^2}$ T: $y - \frac{c}{t} = \frac{1}{t^2}(x - ct)$ Applies $y - \frac{c}{t} = (\text{their } m_r)(x - ct)$ where their m_r has come from calculus T: $t^2y - ct = -x + ct$ At least one line of working. T: $t^2y + x = 2ct *$ Correct solution. A1 cso * [4] (b) $t^2\left(\frac{3c}{5}\right) + \left(-\frac{8c}{5}\right) = 2ct$ Substitutes $\left(-\frac{8c}{5}, \frac{3c}{5}\right)$ into tangent. M1 $3t^2 - 8 = 10t$ $2t - 4, -\frac{2}{3} \Rightarrow A\left(4c, \frac{c}{4}\right), B\left(-\frac{2}{3}c, \frac{3c}{2}\right)$ Uses one of their values of t to find A or B M1 $4LT 1$ (b) $y - \frac{3c}{5} = -\frac{1}{t^2}\left(ct + \frac{8c}{5}\right)$ Substitutes $\left(-\frac{c}{t}\right)$ into Although the original mark scheme. ALT 2 (b) $A\left(ct, \frac{c}{t}\right), B\left(ct, \frac{c}{t_2}\right)$ $t_1^2y + x = 2ct_1$ $t_2^2y + x = 2ct_2$ $t_1^2 + t_2 = \frac{10}{3}, t_1t_2 = -\frac{8}{3}$ Correct 3TQ in terms of t , or t_2 Correct 3TQ in terms of t . A1 Correct 3TQ in terms of t . A1 Correct 3TQ in terms of t . A1 Total 9 Correct 3TQ in terms of t . A1 Correct 3TQ in terms of t . A2 Correct 3TQ in terms of t . A1 Correct 3TQ in terms of t . A1 Correct 3TQ in terms of t . A2 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1 Correct 3TQ in terms of t , or t_2 . A1		or (chain rule) $\frac{dy}{dx} = -ct^{-2} \times \frac{1}{c}$	or $\frac{\text{their } \frac{dy}{dt}}{\text{their } \frac{dx}{dt}}$	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$			$\frac{\mathrm{d}y}{\mathrm{d}x} = -\frac{1}{t^2}$	A1
T: $t^2y - ct = -x + ct$ At least one line of working. T: $t^2y + x = 2ct$ T: $t^2y + x = 2ct$ At least one line of working. At least one line is left. At least one left. At least one left. At least one left. At least one left. At lest of find or left. At left. At lest of the rems of t left. At left. At left. At left. At left. At left. At lest of interms of t left. At left. A		$\mathbf{T}: \ \ y - \frac{c}{t} = -\frac{1}{t^2} \left(x - ct \right)$	l	M1
T: $t^2y + x = 2ct$ * Correct solution. A1 cso * [4] (b) $t^2\left(\frac{3c}{5}\right) + \left(-\frac{8c}{5}\right) = 2ct$ Substitutes $\left(-\frac{8c}{5}, \frac{3c}{5}\right)$ into tangent. M1 $3t^2 - 8 = 10t$ Correct 3TQ in terms of t . Can include uncancelled c . A1 $1 = 4, -\frac{2}{3} \Rightarrow A\left(4c, \frac{c}{4}\right), B\left(-\frac{2}{3}c, -\frac{3c}{2}\right)$ Uses one of their values of t to find A or B M1 $2 = 4, -\frac{2}{3} \Rightarrow A\left(4c, \frac{c}{4}\right), B\left(-\frac{2}{3}c, -\frac{3c}{2}\right)$ Uses one of their values of t to find A or B M1 $3t^2 - 10t - 8 = 0 \Rightarrow t = -\frac{1}{t^2}\left(x\frac{8c}{5}\right)$ Substitutes $\left(ct, \frac{c}{t}\right)$ into M1 $3t^2 - 10t = 8$ Substitutes $\left(ct, \frac{c}{t}\right)$ into M1 $3t^2 - 10t = 8$ Correct 3TQ in terms of t . Can include uncancelled c . A1 $4t = 1$ ALT 2 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1 $4t = 1$ Can include uncancelled c . A1		$T: t^2y$ of $-x + ot$	-	
(b) $ \begin{aligned} & r^2 \left(\frac{3c}{5} \right) + \left(-\frac{8c}{5} \right) = 2ct \end{aligned} \end{aligned} \qquad \text{Substitutes} \left(-\frac{8c}{5}, \frac{3c}{5} \right) \text{ into tangent.} \qquad \text{M1} $ $ \begin{aligned} & 3t^2 - 8 = 10t & & & & & & & & & & & & & & & & & & &$				A1 cso *
(b) $ \begin{aligned} & t^2 \left(\frac{3c}{5}\right) + \left(-\frac{8c}{5}\right) = 2ct \end{aligned} \end{aligned} \qquad \begin{aligned} & \text{Substitutes} \left(-\frac{8c}{5}, \frac{3c}{5}\right) \text{ into tangent.} & \text{M1} \\ & 3t^2 - 8 = 10t \end{aligned} \qquad \begin{aligned} & \text{Correct 3TQ in terms of } t \\ & \left\{3t^2 - 10t - 8 = 0 \Rightarrow\right\} (t - 4)(3t + 2) = 0 \Rightarrow t = \dots \end{aligned} \qquad \end{aligned} \end{aligned} \qquad \begin{aligned} & \text{Attempt to solve their 3TQ for } t \\ & \text{M1} \end{aligned} \\ & t = 4, -\frac{2}{3} \Rightarrow A \left(4c, \frac{c}{4}\right), B \left(-\frac{2}{3}c, -\frac{3c}{2}\right) \end{aligned} \qquad \end{aligned} \end{aligned} \qquad \begin{aligned} & \text{Uses one of their values of } t \text{ to find } A \text{ or } B \\ & \text{Correct coordinates.} \end{aligned} \\ & \text{Condone } A \text{ and } B \text{ swapped or missing.} \end{aligned} \end{aligned} \qquad \begin{aligned} & \text{Substitutes} \left(ct, \frac{c}{t}\right) \text{ into} \\ & \Rightarrow \frac{c}{t} - \frac{3c}{5} = -\frac{1}{t^2} \left(ct + \frac{8c}{5}\right) \end{aligned} \qquad \end{aligned} \qquad \begin{aligned} & \text{Substitutes} \left(ct, \frac{c}{t}\right) \text{ into} \\ & \Rightarrow \frac{c}{t} - \frac{3c}{5} = -\frac{1}{t^2} \left(ct + \frac{8c}{5}\right) \end{aligned} \qquad \end{aligned} \qquad \end{aligned} \end{aligned} \qquad \begin{aligned} & \text{Substitutes} \left(ct, \frac{c}{t}\right) \text{ into} \\ & \text{Al } \end{aligned}$ $= \frac{ALT 1}{t} \end{aligned} $ $= \frac{ALT 2}{t} \end{aligned} \end{aligned} \end{aligned} \qquad \begin{aligned} & A \left(ct_1, \frac{c}{t_1}\right), B \left(ct_2, \frac{c}{t_2}\right) \end{aligned} \qquad \end{aligned} \qquad \end{aligned} \qquad \end{aligned} \qquad \end{aligned} \qquad \end{aligned} \qquad \end{aligned} \end{aligned} \end{aligned} \qquad \end{aligned} \end{aligned} \qquad \end{aligned} \end{aligned} \qquad \end{aligned} \end{aligned} \end{aligned} \end{aligned} \end{aligned} \end{aligned} \qquad \end{aligned} \end{aligned} \end{aligned} \end{aligned} \end{aligned} \qquad \end{aligned} \end{aligned}$		1. 1 9 1 3 201	Correct solution.	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	(b)	$t^2 \left(\frac{3c}{5}\right) + \left(-\frac{8c}{5}\right) = 2ct$	Substitutes $\left(-\frac{8c}{5}, \frac{3c}{5}\right)$ into tangent.	
$t = 4, -\frac{2}{3} \Rightarrow A\left(4c, \frac{c}{4}\right), B\left(-\frac{2}{3}c, -\frac{3c}{2}\right)$ $t = 4, -\frac{2}{3} \Rightarrow A\left(4c, \frac{c}{4}\right), B\left(-\frac{2}{3}c, -\frac{3c}{2}\right)$ $t = 4, -\frac{2}{3} \Rightarrow A\left(4c, \frac{c}{4}\right), B\left(-\frac{2}{3}c, -\frac{3c}{2}\right)$ $t = 4, -\frac{2}{3} \Rightarrow A\left(4c, \frac{c}{4}\right), B\left(-\frac{2}{3}c, -\frac{3c}{2}\right)$ $t = 4, -\frac{2}{3} \Rightarrow A\left(4c, \frac{c}{4}\right), B\left(-\frac{2}{3}c, -\frac{3c}{2}\right)$ $t = \frac{3c}{5} \Rightarrow -\frac{1}{t^2}\left(x - \frac{8c}{5}\right)$ $t = \frac{1}{t^2}\left(x - \frac{8c}{5}\right)$ $t = \frac{1}{t^2}\left(x$		$3t^2 - 8 = 10t$	I -	A1
$t = 4, -\frac{2}{3} \Rightarrow A \left(4c, \frac{c}{4}\right), B\left(-\frac{2}{3}c, -\frac{3c}{2}\right)$ $Correct coordinates. Condone A and B swapped or missing.$ All ALT 1 (b) $y - \frac{3c}{5} = -\frac{1}{t^2}\left(x - \frac{8c}{5}\right)$ $3t^2 - 10t = 8$ $then apply the original mark scheme.$ ALT 2 (b) $A\left(ct_1, \frac{c}{t_1}\right), B\left(ct_2, \frac{c}{t_2}\right)$ $tt_1^2y + x = 2ct_1$ $tt_2^2y + x = 2ct_2$ $tt_1 + t_2 = \frac{10}{3}, t_1t_2 = -\frac{8}{3}$ Correct 3TQ in terms of t . Can include uncancelled c . M1 Substitutes A and B into the equation of the tangent, solves for x and y The equation of the tangent, solves for x and y Correct 3TQ in terms of t . All Correct 3TQ in terms of t . All correct 3TQ in terms of t . All correct 3TQ in terms of t . All correct 3TQ in terms of t . All correct 3TQ in terms of t . All correct 3TQ in terms of t . All correct 3TQ in terms of t . All correct 3TQ in terms of t . All correct 3TQ in terms of t . All correct 3TQ in terms of t . All correct 3TQ in terms of t . All correct 3TQ in terms of t . All correct 3TQ in terms of t .		${3t^2 - 10t - 8 = 0}$ $(t - 4)(3t + 2) = 0 \Rightarrow t =$	Attempt to solve their 3TQ for t	M1
Condone A and B swapped or missing. ALT 1 (b) $y - \frac{3c}{5} = -\frac{1}{t^2}\left(x - \frac{8c}{5}\right)$ Substitutes $\left(ct, \frac{c}{t}\right)$ into $\Rightarrow \frac{c}{t} - \frac{3c}{5} = -\frac{1}{t^2}\left(ct + \frac{8c}{5}\right)$ Substitutes $\left(ct, \frac{c}{t}\right)$ into $\Rightarrow \frac{c}{t} - \frac{3c}{5} = -\frac{1}{t^2}\left(ct + \frac{8c}{5}\right)$ Correct 3TQ in terms of t. Can include uncancelled c. Al ALT 2 (b) $A\left(ct_1, \frac{c}{t_1}\right), B\left(ct_2, \frac{c}{t_2}\right)$ Substitutes A and B into the equation of the tangent, solves for x and y $t_1^2y + x = 2ct_1$ $t_2^2y + x = 2ct_2$ $t_1 + t_2 = \frac{10}{3}, t_1t_2 = -\frac{8}{3}$ Correct 3TQ in terms of t_1 or t_2 Can include uncancelled c.		. 2 .(. c) _(2 3c)		M1
ALT 1 (b) $y - \frac{3c}{5} = -\frac{1}{t^2} \left(x - \frac{8c}{5} \right)$ $\Rightarrow \frac{c}{t} - \frac{3c}{5} = -\frac{1}{t^2} \left(ct + \frac{8c}{5} \right)$ $3t^2 - 10t = 8$ $\text{their } y - \frac{3c}{5} = -\frac{1}{t^2} \left(x - \frac{8c}{5} \right)$ Total 9 M1 Total 9 $\text{Substitutes } \left(ct, \frac{c}{t} \right) \text{ into }$ $\text{their } y - \frac{3c}{5} = -\frac{1}{t^2} \left(x - \frac{8c}{5} \right)$ $3t^2 - 10t = 8$ $\text{Correct 3TQ in terms of } t.$ $\text{Can include uncancelled } c.$ $\text{Substitutes } A \text{ and } B \text{ into }$ $\text{the equation of the tangent, solves for }$ $x \text{ and } y$ $t_1^2 y + x = 2ct_1$ $t_2^2 y + x = 2ct_2$ $t_1 + t_2 = \frac{10}{3}, t_1 t_2 = -\frac{8}{3}$ $3t^2 - 8 = 10t$ $\text{Correct 3TQ in terms of } t_1 \text{ or } t_2$ $\text{Can include uncancelled } c.$		$t=4, -\frac{1}{3} \Rightarrow A\left(4c, \frac{1}{4}\right), B\left(-\frac{1}{3}c, -\frac{1}{2}\right)$		A1
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$				
$3t^2 - 10t = 8$ $\text{Correct 3TQ in terms of } t.$ $\text{Can include uncancelled } c.$ $\text{then apply the original mark scheme.}$ $ALT 2 \\ \text{(b)}$ $A\left(ct_1, \frac{c}{t_1}\right), B\left(ct_2, \frac{c}{t_2}\right)$ $t_1^2y + x = 2ct_1$ $t_2^2y + x = 2ct_2$ $t_1 + t_2 = \frac{10}{3}, t_1t_2 = -\frac{8}{3}$ $3t^2 - 8 = 10t$ $\text{Correct 3TQ in terms of } t.$ A1 $\text{Substitutes } A \text{ and } B \text{ into the equation of the tangent, solves for } x \text{ and } y$ $\text{Correct 3TQ in terms of } t_1 \text{ or } t_2 \text{ Can include uncancelled } c.$, ,		
then apply the original mark scheme. ALT 2 (b) $A\left(ct_1, \frac{c}{t_1}\right), B\left(ct_2, \frac{c}{t_2}\right)$ Substitutes A and B into the equation of the tangent, solves for x and y $t_1^2y + x = 2ct_1$ $t_2^2y + x = 2ct_2$ $t_1 + t_2 = \frac{10}{3}, t_1t_2 = -\frac{8}{3}$ Correct 3TQ in terms of t_1 or t_2 A1 $3t^2 - 8 = 10t$ Can include uncancelled c .			Correct 3TQ in terms of t .	A1
ALT 2 (b) $A\left(ct_1, \frac{c}{t_1}\right), B\left(ct_2, \frac{c}{t_2}\right)$ Substitutes A and B into the equation of the tangent, solves for x and y $t_1^2y + x = 2ct_1$ $t_2^2y + x = 2ct_2$ $t_1 + t_2 = \frac{10}{3}, t_1t_2 = -\frac{8}{3}$ Correct 3TQ in terms of t_1 or t_2 A1 Can include uncancelled c.			Can include uncancelled c.	
$t_1^2 y + x = 2ct_1$ $t_2^2 y + x = 2ct_2$ $t_1 + t_2 = \frac{10}{3}, t_1 t_2 = -\frac{8}{3}$ $3t^2 - 8 = 10t$ Correct 3TQ in terms of t_1 or t_2 A1 Can include uncancelled c .			the equation of the tangent, solves for	M1
$3t^2 - 8 = 10t$ Correct 3TQ in terms of t_1 or t_2 Can include uncancelled c .		$\begin{aligned} t_1^2 y + x &= 2ct_1 \\ t_2^2 y + x &= 2ct_2 \end{aligned}$	x and y	
$3t^2 - 8 = 10t$ Can include uncancelled c.		$t_1 + t_2 = \frac{10}{3}, \ t_1 t_2 = -\frac{8}{3}$		
		$3t^2 - 8 = 10t$		A1
		then apply original scheme		

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Question Number	Scheme		Marks
6. (a)	$\left\{ \det \mathbf{M} = (8)(2) - (-1)(-4) \right\} \Rightarrow \det \mathbf{M} = 12$	12	B1
			[1]
(b)	Area $T = \frac{216}{12} \{=18\}$	Area $T = \frac{216}{\text{their "det M"}}$	M1
	$h = \pm (1 - k)$	Uses $(k-1)$ or $(1-k)$ in their solution.	M1
	$\frac{1}{2}8(k-1) = 18$ or $\frac{1}{2}8(1-k) = 18$ or	dependent on the two previous M marks $\frac{1}{2}8(k-1) \text{ or } \frac{1}{2}8(1-k) = \frac{216}{\text{their "det M"}}$	
	$(k-1) = \frac{18}{4}$ or $(1-k) = \frac{18}{4}$ or	or $(k-1)$ or $(1-k) = \frac{216}{4(\text{their "det }\mathbf{M"})}$	ddM1
	$\{\frac{1}{2}8h = 18\} \Rightarrow h = \frac{9}{2}, k = 1 \pm \frac{9}{2}$	or $h = \frac{216}{4(\text{their "det }\mathbf{M"})}, k = 1 \pm \frac{216}{4(\text{their "det }\mathbf{M"})}$	
	$\Rightarrow k = 5.5 \text{ or } k = -3.5$	At least one of either $k = 5.5$ or $k = -3.5$	A1
	$\Rightarrow k = 3.5 \text{ or } k = -3.5$	Both $k = 5.5$ and $k = -3.5$	A1
			[5]
ALT (b)	$\mathbf{T}' = \begin{pmatrix} 8 & -1 \\ -4 & 2 \end{pmatrix} \begin{pmatrix} 4 & 6 & 12 \\ 1 & k & 1 \end{pmatrix}$		
	$\mathbf{T'} = \begin{pmatrix} 31 & 48 - k & 95 \\ -14 & -24 + 2k & -46 \end{pmatrix} \text{ or } 18 \text{ seen}$	At least 5 out of 6 elements are correct or 18 seen	M1
	$\begin{vmatrix} \frac{1}{2} \begin{vmatrix} 31 & 48 - k & 95 & 31 \\ -14 & -24 + 2k & -46 & -14 \end{vmatrix} = 216$ or $\frac{1}{2} \begin{vmatrix} 4 & 6 & 12 & 4 \\ 1 & k & 1 & 1 \end{vmatrix} = 18$	$\frac{1}{2}$ their \mathbf{T}' = 216 or $\frac{1}{2}$ $\begin{vmatrix} 4 & 6 & 12 & 4 \\ 1 & k & 1 & 1 \end{vmatrix}$ = 18	M1
	$\frac{1}{2} \begin{vmatrix} -744 + 62k + 672 - 14k - 2208 + 46k \\ +2280 - 190k - 1330 + 1426 \end{vmatrix} =$	Dependent on the two previous M marks. Full method of evaluating a determinant.	ddM1
	$\frac{1}{2} 4k-6+6-12k+12-4 =18$		
	$\frac{1}{2} 96 - 96k = 216 \text{ or } \frac{1}{2} 8 - 8k = 18$		
	So, $1-k = 4.5$ or $k-1 = 4.5$		
	$\Rightarrow k = -3.5 \text{ or } k = 5.5$	At least one of either $k = -3.5$ or $k = 5.5$	A1
	, 10 01 N 010	Both $k = -3.5$ and $k = 5.5$	A1
			[5]
			Total 6

7. (a) $y^2 = 4ax$, $S(a,0)$, $D\left(-a, \frac{24a}{5}\right)$. $P(ak^2, 2ak)$ (a) $\frac{24a}{m_1} = \frac{24a}{5-0} = \frac{24a}{5-0} = \frac{12}{5-2a} = -\frac{12}{5}$ Uses $S(a,0)$ and $D\left(\text{their "-a", } \frac{24a}{5-5}\right)$ to find an expression for the gradient of l or applies the formula $\frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$ M1 Can be un-simplified or simplified. 1: $y - 0 = -\frac{12}{5}(x-a) \Rightarrow 5y = -12x + 12a$ Correct solution only leading to $12x + 5y = 12a$ No errors seen. ALT (a) $y = mx + c$ Uses $S(a,0)$ and $D\left(\text{their "-a", } \frac{24a}{5-5}\right)$ to find 2 simultaneous equations and solves to achieve $c =, m =$ (b) $m_{sr} = \frac{2ak}{ak^2-a} = \frac{2k}{k^2-1}$ Attempts to find the gradient of SP M1 So $\left\{\frac{2k}{k^2-1} = \frac{5}{12} \Rightarrow\right\} 24k = 5k^2 - 5$ Correct 3TQ in terms of k in any form. A1 $\left\{5k^2 - 24k - 5 = 0 \Rightarrow\right\} (k-5)(5k+1) = 0 \Rightarrow k =$ Attempt to solve their 3TQ for k M1	Question Number	Scheme	Notes	Marks
$\frac{y-\frac{24a}{5}}{0-\frac{24a}{5}} = \frac{xa}{aa} \text{ or } \frac{y-0}{\frac{24a}{5}-0} = \frac{x-a}{-a-a}$ $\frac{y-\frac{24a}{5}}{0-\frac{24a}{5}} = \frac{xa}{aa} \text{ or } \frac{y-0}{\frac{24a}{5}-0} = \frac{x-a}{-a-a}$ $\frac{1: y-0=-\frac{12}{5}(x-a) \Rightarrow 5y=-12x+12a}{1: 12x+5y=12a (*)}$ $\frac{y=mx+c}{5}$ $ALT (a)$ $\frac{y=mx+c}{5}$ $At D, \frac{24a}{5} = -ma+c$ $\Rightarrow c = \frac{12a}{5}, m = -\frac{12}{5}$ $y = -\frac{12}{5}x + \frac{12a}{5} \Rightarrow 12x+5y=12a *$ $\frac{y-y-y_1}{y-y-y_1} = \frac{x-x_1}{x_2-x_1}$ $\frac{x}{y-x_1} = \frac{x-x_1}{x_1-x_1}$ $\frac{x}{y-x_1} = x-x_1$	7.	$y^2 = 4ax$, $S(a,0)$, $D\left(-a, \frac{24a}{5}\right)$, $P(ak^2, 2ak)$		
ALT (a)	(a)	J	find an expression for the gradient of l or applies the formula $\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$	M1
ALT (a)		1: $y - 0 = -\frac{1}{5}(x - a) \Rightarrow 5y = -12x + 12a$	leading to $12x + 5y = 12a$	
$y = -\frac{12}{5}x + \frac{12a}{5} \Rightarrow 12x + 5y = 12a^*$ Correct solution only leading to $12x + 5y = 12a$ A1* [2] (b) $m_{SP} = \frac{2ak}{ak^2 - a} \left\{ = \frac{2k}{k^2 - 1} \right\}$ Attempts to find the gradient of SP M1 $m_l = -\left(\frac{ak^2 - a}{2ak}\right) \text{ or } m_{SP} = -\frac{1}{\left(-\frac{12}{5}\right)} \left\{ = \frac{5}{12} \right\}$ Some evidence of applying $m_l m_2 = -1$ M1 $So\left\{ \frac{2k}{k^2 - 1} = \frac{5}{12} \Rightarrow \right\} 24k = 5k^2 - 5$ Correct 3TQ in terms of k in any form. A1 $\left\{ 5k^2 - 24k - 5 = 0 \Rightarrow \right\} (k - 5)(5k + 1) = 0 \Rightarrow k = \dots$ Attempt to solve their 3TQ for k M1 $\left\{ As \ k > 0, \text{ so } k = 5 \right\} \Rightarrow (25a, 10a)$ Uses their k to find P M1 $\left\{ 25a, 10a \right\}$ A1*	ALT (a)	At S, $0 = ma + c$ At D, $\frac{24a}{5} = -ma + c$	find 2 simultaneous equations and solves	
(b) $ m_{SP} = \frac{2ak}{ak^2 - a} \left\{ = \frac{2k}{k^2 - 1} \right\} $ Attempts to find the gradient of SP M1 $ m_l = -\left(\frac{ak^2 - a}{2ak}\right) \text{ or } m_{SP} = -\frac{1}{\left(-\frac{12}{5}\right)} \left\{ = \frac{5}{12} \right\} $ Some evidence of applying $m_l m_2 = -1$ M1 $ So \left\{ \frac{2k}{k^2 - 1} = \frac{5}{12} \Rightarrow \right\} 24k = 5k^2 - 5 $ Correct 3TQ in terms of k in any form. A1 $ \left\{ 5k^2 - 24k - 5 = 0 \Rightarrow \right\} (k - 5)(5k + 1) = 0 \Rightarrow k = \dots $ Attempt to solve their 3TQ for k M1 $ \left\{ As \ k > 0, \text{ so } k = 5 \right\} \Rightarrow (25a, 10a) $ Uses their k to find k M1 $ \left\{ As \ k > 0, \text{ so } k = 5 \right\} \Rightarrow (25a, 10a) $			•	
So $\left\{\frac{2k}{k^2 - 1} = \frac{5}{12} \Rightarrow\right\}$ 24 $k = 5k^2 - 5$ Correct 3TQ in terms of k in any form. A1 $\left\{5k^2 - 24k - 5 = 0 \Rightarrow\right\} (k - 5)(5k + 1) = 0 \Rightarrow k = \dots$ Attempt to solve their 3TQ for k M1 $\left\{\text{As } k > 0, \text{ so } k = 5\right\} \Rightarrow (25a, 10a)$ Uses their k to find k M1 $\left\{\text{Correct 3TQ in terms of } k \text{ in any form.} \right\}$ A1 $\left\{\text{Correct 3TQ in terms of } k \text{ in any form.} \right\}$ M1 $\left\{\text{Correct 3TQ in terms of } k \text{ in any form.} \right\}$ A1	(b)	$m_{SP} = \frac{2ak}{ak^2 - a} \left\{ = \frac{2k}{k^2 - 1} \right\}$	Attempts to find the gradient of SP	
$ \left\{ 5k^2 - 24k - 5 = 0 \Rightarrow \right\} (k - 5)(5k + 1) = 0 \Rightarrow k = \dots $ Attempt to solve their 3TQ for k M1 $ \left\{ \text{As } k > 0, \text{ so } k = 5 \right\} \Rightarrow (25a, 10a) $ Uses their k to find k M1 $ \left\{ \text{As } k > 0, \text{ so } k = 5 \right\} \Rightarrow (25a, 10a) $ (25a, 10a) A1		$m_l = -\left(\frac{ak^2 - a}{2ak}\right)$ or $m_{SP} = -\frac{1}{(-\frac{12}{5})}\left\{=\frac{5}{12}\right\}$	Some evidence of applying $m_1 m_2 = -1$	M1
$\left\{ \text{As } k > 0 \text{, so } k = 5 \right\} \Rightarrow (25a, 10a)$ Uses their k to find P $(25a, 10a)$ $(25a, 10a)$ A1			Correct 3TQ in terms of k in any form.	A1
$\{As \ k > 0, so \ k = 5\} \Rightarrow (25a, 10a)$ (25a, 10a) A1		${5k^2 - 24k - 5 = 0 \Rightarrow} (k - 5)(5k + 1) = 0 \Rightarrow k =$		M1
(23u, 10u) Al		$\{ \text{As } k > 0, \text{ so } k = 5 \} \Rightarrow (25a, 10a)$		
		, , , , , ,	(25a, 10a)	A1 [6]

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Mathematics FP1 6667

ALT 1	5	$y - 0 = m_{SP}(x - a)$	M1
(b)	$SP: \ y - 0 = \frac{5}{12}(x - a)$	$m_{SP} = -\frac{1}{(-\frac{12}{5})} \left\{ = \frac{5}{12} \right\}$	M1
	$\left\{y^2 = 4ax \Longrightarrow\right\} \left(\frac{5}{12}(x-a)\right)^2 = 4ax$	Can sub for x and achieve $\frac{12}{5}y + a$	
	$25(x^2 - 2ax + a^2) = 576ax$		
	$25x^2 - 626ax + 25a^2 = 0$	Correct 3TQ in terms of a and x or $5y^2 - 48ay - 20a^2 = 0$	A1
	$(25x-a)(x-25a) = 0 \implies x = \dots$	Attempt to solve their 3TQ for x	M1
	$x = \frac{a}{25} \Rightarrow y = \frac{5}{12} \left(\frac{a}{25} - a \right) \left\{ = -\frac{2a}{5} \right\}$ $x = 25a \Rightarrow y = \frac{5}{12} \left(25a - a \right) \left\{ = 10a \right\}$	Uses their x to find y	M1
	$\{As \ k > 0, \} \Rightarrow (25a, 10a)$	(25a, 10a)	A1
			[6]
ALT 2 (b)	$0 = m_{SP}a + c$	Subs S into $y = m_{SP}x + c$ to find c	M1
	$m_{SP} = -\frac{1}{(-\frac{12}{5})} \left\{ = \frac{5}{12} \right\}$	Some evidence of applying $m_1 m_2 = -1$	M1
	$y = \frac{5}{12}x - \frac{5}{12}a$		
	At P, $2ak = \frac{5}{12}ak^2 - \frac{5}{12}a$	Correct 3TQ in terms of k	A1
	then as part (b)		
			Total 8

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Question	Scheme	Notes	Marks
Number 8.	$f(n) = 2^{n+2} + 3^{2n+1}$ divisible by 7		
	$f(1) = 2^3 + 3^3 = 35$ {which is divisible by 7}.	Shows $f(1) = 35$	B1
	$\{ : f(n) \text{ is divisible by 7 when } n=1 \}$		
	{Assume that for $n = k$,		
	$f(k) = 2^{k+2} + 3^{2k+1}$ is divisible by 7 for $k \in \mathbb{Z}^+$.		
	$f(k+1) - f(k) = 2^{k+1+2} + 3^{2(k+1)+1} - (2^{k+2} + 3^{2k+1})$	Applies $f(k+1)$ with at least 1 power correct	M1
	$f(k+1) - f(k) = 2(2^{k+2}) + 9(3^{2k+1}) - (2^{k+2} + 3^{2k+1})$		
	$f(k+1) - f(k) = 2^{k+2} + 8(3^{2k+1})$		
	$= (2^{k+2} + 3^{2k+1}) + 7(3^{2k+1})$	$(2^{k+2} + 3^{2k+1})$ or $f(k)$; $7(3^{2k+1})$	A1; A1
	$\mathbf{or} = 8(2^{k+2} + 3^{2k+1}) - 7(2^{k+2})$	or $8(2^{k+2}+3^{2k+1})$ or $8f(k);-7(2^{k+2})$	
	$= f(k) + 7(3^{2k+1})$		
	$\mathbf{or} = 8f(k) - 7(2^{k+2})$		
	$f(k+1) = 2f(k) + 7(3^{2k+1})$	Dependent on at least one of the previous	13.61
	or $f(k+1) = 9f(k) - 7(2^{k+2})$	accuracy marks being awarded. Makes $f(k+1)$ the subject	dM1
	$\{ : f(k+1) = 2f(k) + 7(3^{2k+1}) \text{ is divisible by 7 as } $		
	both $2f(k)$ and $7(3^{2k+1})$ are both divisible by 7}		
	If the result is true for $n = k$, then it is now true	Correct conclusion seen at the end. Condone	
	for $n = k+1$. As the result has shown to be true	true for $n = 1$ stated earlier.	A1 cso
	for $n = 1$, then the result is true for all $n \in \mathbb{Z}^+$.		5.61
A T /D	$f(k+1) - \alpha f(k) = 2^{k+3} + 3^{2k+3} - \alpha (2^{k+2} + 3^{2k+1})$	Applies $f(k+1)$ with at least 1 power correct	[6] M1
ALT		Applies 1 (k + 1) with at least 1 power correct	1411
	$f(k+1) - \alpha f(k) = (2-\alpha)2^{k+2} + (9-\alpha)3^{2k+1}$	(2) (2k+2) (2k+1) (2) (3k+1) (3k+1)	
	$f(k+1) - \alpha f(k) = (2-\alpha)(2^{k+2} + 3^{2k+1}) + 7.3^{2k+1}$ or	$(2-\alpha)(2^{k+2}+3^{2k+1})$ or $(2-\alpha)f(k)$; 7.3 ^{2k+1} or	A1;A1
	$f(k+1) - \alpha f(k) = (9 - \alpha)(2^{k+2} + 3^{2k+1}) - 7 \cdot 2^{k+2}$	$(9-\alpha)(2^{k+2}+3^{2k+1})$ or $(9-\alpha)f(k)$; -7.2^{k+2}	ĺ
		NB: Choosing $\alpha = 0, \alpha = 2, \alpha = 9$ will	
		make relevant terms disappear, but marks	
		should be awarded accordingly.	To4-1.6
			Total 6

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Question Number	Scheme		Marks
	$\frac{3w+7}{5} = \frac{\left(p-4i\right)}{\left(3-i\right)} \times \frac{\left(3+i\right)}{\left(3+i\right)}$	Multiplies by $\frac{(3+i)}{(3+i)}$	
9. (i) (a)		or divide by $(9-3i)$ then multiply by	M1
		$\frac{(9+3i)}{(9+3i)}$	
	(2n+4) $(n-12)$	Evidence of $(3-i)(3+i) = 10$ or $3^2 + 1^2$	
	$= \left(\frac{3p+4}{10}\right) + \left(\frac{p-12}{10}\right)i$	or $9^2 + 3^2$	B1
		Rearranges to $w =$	dM1
	So, $w = \left(\frac{3p-10}{6}\right) + \left(\frac{p-12}{6}\right)i$	At least one of either the real or imaginary part of <i>w</i> is correct in any equivalent form.	A1
	(6) (6)	Correct w in the form $a + bi$.	A1
		Accept $a + ib$.	
ALT	(3-i)(3w+7) = 5(p-4i)		[5]
(i) (a)	9w + 21 - 3iw - 7i = 5p - 20i		
	w(9-3i) = 5p-21-13i		
	Let $w = a + bi$, so		
	(a+bi)(9-3i) = 5p-21-13i		
	$9a + 3b - 3a\mathbf{i} + 9b\mathbf{i} = 5p - 21 - 13\mathbf{i}$		
	Real: $9a + 3b = 5p - 21$	Sets $w = a + bi$ and equates at least either	M1
	Imaginary: $-3a+9b = -13$	the real or imaginary part. $9a+3b = 5p-21$	B1
	$b = \frac{p-12}{6}$, $a = \frac{3p-10}{6}$	Solves to finds $a =$ and $b =$	dM1
	$b = \frac{1}{6}$, $a = \frac{1}{6}$	At least one of <i>a</i> or <i>b</i> is correct in any equivalent form.	A1
	$w = \left(\frac{3p - 10}{6}\right) + \left(\frac{p - 12}{6}\right)i$	Correct w in the form $a + bi$. Accept $a + ib$.	A1
			[5]
(b)	$\left\{\arg w = -\frac{\pi}{2} \Rightarrow \left(\frac{3p-10}{6}\right) = 0\right\} \Rightarrow p = \frac{10}{3}$	$p = \frac{10}{3}$ Follow through provided $p < 12$	B1ft
		1 onow amough provided $p < 12$	[1]
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Mathematics FP1

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(ii)	$(x+iy+1-2i)^* = 4i(x+iy)$	Replaces z with $x + iy$ on both sides of the equation	M1
	x-iy+1+2i = 4i(x+iy) or x+iy+1-2i = -4i(x-iy)	Fully correct method for applying the conjugate	M1
	x - iy + 1 + 2i = 4ix - 4y		
	Real: $x+1 = -4y$ Imaginary: $-y+2=4x$	x+1 = -4y and $-y+2 = 4x$	A1
	$4x+16y = -4$ $4x + y = 2$ $\Rightarrow 15y = -6 \Rightarrow y = \dots$	Solves two equations in x and y to obtain at least one of x or y	ddM1
	So, $x = \frac{3}{5}$, $y = -\frac{2}{5}$ $\left\{z = \frac{3}{5} - \frac{2}{5}i\right\}$	At least one of either <i>x</i> or <i>y</i> are correct	A1
		Both x and y are correct	A1
			[6]
			Total 12

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Mathematics FP1

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