Past Paper

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Surname	Other names
Pearson Edexcel GCE	Centre Number Candidate Number
Further F	-
Mathema Advanced/Advan	atics FP1 ced Subsidiary
	ced Subsidiary Afternoon Paper Reference

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided
 there may be more space than you need.
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information

- The total mark for this paper is 75.
- The marks for each question are shown in brackets
 use this as a quide as to how much time to spend on each question.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶





Past Paper

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 $f(z) = 2z^3 - 4z^2 + 15z - 13$ 1.

(a) find the value of a and the value of b.

- **(2)**
- (b) Hence use algebra to find the three roots of the equation f(z) = 0

Given that $f(z) \equiv (z-1)(2z^2 + az + b)$, where a and b are real constants,

(4)



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Mathematics FP1 6667

Question Number	Scheme Notes		Marks
1.	$f(z) = 2z^3 - 4z^2 + 15z - 13 \equiv (z - 1)(2z^2 + az + b)$		
(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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Mathematics FP1

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$$f(x) = \frac{3}{2}x^2 + \frac{4}{3x} + 2x - 5, \qquad x < 0$$

The equation f(x) = 0 has a single root α .

(a) Show that α lies in the interval [-3, -2.5]

(2)

(b) Taking -3 as a first approximation to α , apply the Newton-Raphson procedure once to f(x) to obtain a second approximation to α . Give your answer to 3 decimal places.

(c) Use linear interpolation once on the interval $\begin{bmatrix} -3, -2.5 \end{bmatrix}$ to find another approximation to α , giving your answer to 3 decimal places.

(3)

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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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Mathematics FP1 6667

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

3. (i) Given that

$$\mathbf{A} = \begin{pmatrix} -2 & 3 \\ 1 & 1 \end{pmatrix}, \quad \mathbf{AB} = \begin{pmatrix} -1 & 5 & 12 \\ 3 & -5 & -1 \end{pmatrix}$$

(a) find \mathbf{A}^{-1}

- **(2)**
- (b) Hence, or otherwise, find the matrix \mathbf{B} , giving your answer in its simplest form.
 - (3)

(ii) Given that

$$\mathbf{C} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$$

- (a) describe fully the single geometrical transformation represented by the matrix C.
 - (2)

(b) Hence find the matrix C^{39}

(2)

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 C^{-1} or 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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(a) Use the standard results for $\sum_{r=1}^{n} r$ and $\sum_{r=1}^{n} r^2$ to show that, for all positive integers n,

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$$\sum_{r=1}^{n} (r^{2} - r - 8) = \frac{1}{3}n(n-a)(n+a)$$

where a is a positive integer to be determined.

(4)

(b) Hence, or otherwise, state the positive value of *n* that satisfies

$$\sum_{r=1}^{n} \left(r^2 - r - 8 \right) = 0$$

(1)

Given that

$$\sum_{r=3}^{17} (kr^3 + r^2 - r - 8) = 6710$$
 where k is a constant

(c) find the exact value of k.

(4)

Mathematics FP1 6667

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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
	$(\Sigma - 6710 \rightarrow) 23400k 0k + 1406 + 14 - 6710 \rightarrow k - 2$	and solves to give $k =$	ddM1
	$\{\Sigma = 6710 \Rightarrow\} 23409k - 9k + 1496 + 14 = 6710 \Rightarrow k = \frac{2}{9}$	$k = \frac{2}{9} \text{ or } 0.\dot{2}$	A1 cso
			[4]
			Total 9

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The rectangular hyperbola H has equation $xy = c^2$, where c is a positive constant.

Given that $P\left(ct, \frac{c}{t}\right)$, $t \neq 0$, is a general point on H,

(a) use calculus to show that the equation of the tangent to H at P can be written as

$$t^2y + x = 2ct$$

(4)

The points A and B lie on H.

The tangent to H at A and the tangent to H at B meet at the point $\left(-\frac{8c}{5}, \frac{3c}{5}\right)$.

Given that the x coordinate of A is positive,

(b) find, in terms of c, the coordinates of A and the coordinates of B.

(5)



$\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: $t = 4$, $-\frac{2}{3} \Rightarrow A\left(4c, \frac{c}{4}\right)$, $B\left(-\frac{2}{3}c, -\frac{3c}{2}\right)$ Uses one of their values of t to find A or B Correct coordinates. Condone A and B swapped or missing. Al. T: $t = 4$, $t =$		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 . $		$y = c^2 x^{-1} \Rightarrow \frac{dy}{dx} = -c^2 x^{-2}$	$\frac{1}{dx} = \pm k x$	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		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 . OTHER A1 Correct 3TQ in terms of t . OTHER A2 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A1 Correct 3TQ in terms of t . OTHER A2 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correct 3TQ in terms of t . OTHER A3 Correc		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		$\mathbf{T}: \ \ y - \frac{c}{t} = -\frac{1}{t^2} \left(x - ct \right)$	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 $4t = 1$ 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} $ $= \frac{ALT 2}{t} \end{aligned} \end{aligned} \end{aligned} \qquad \begin{aligned} & A \left(ct_1, \frac{c}{t_1}\right), B \left(ct_2, \frac{c}{t_2}\right) \end{aligned} \qquad \end{aligned} \qquad \end{aligned} \qquad \end{aligned} \qquad \end{aligned} \qquad \end{aligned} \qquad \end{aligned} \end{aligned} \end{aligned} \end{aligned} \qquad \end{aligned} \end{aligned} \end{aligned} \qquad \end{aligned} \end{aligned} \end{aligned} \end{aligned} \end{aligned} \end{aligned} \end{aligned} \qquad \end{aligned} \end{aligned}$		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 . All correct 3TQ in terms of t .		$\left\{3t^2 - 10t - 8 = 0 \Longrightarrow\right\} (t - 4)(3t + 2) = 0 \Longrightarrow t = \dots$	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$				
$3t^2 - 10t = 8$ $\text{Correct 3TQ in terms of } t.$ $\text{Can include uncancelled } c.$ $\text{then apply the original mark scheme.}$ $ALT 2 \\ \text{(b)}$ $A \left(ct_1, \frac{c}{t_1} \right), B \left(ct_2, \frac{c}{t_2} \right)$ $t_1^2 y + x = 2ct_1$ $t_2^2 y + x = 2ct_2$ $t_1 + t_2 = \frac{10}{3}, t_1 t_2 = -\frac{8}{3}$ $3t^2 - 8 = 10t$ $Correct 3TQ in terms of t_1 or t_2 Can include uncancelled c.$, ,		
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$t_1^2 y + x = 2ct_1$ $t_2^2 y + x = 2ct_2$ $t_1 + t_2 = \frac{10}{3}, t_1 t_2 = -\frac{8}{3}$ $3t^2 - 8 = 10t$ Correct 3TQ in terms of t_1 or t_2 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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6.

$$\mathbf{M} = \begin{pmatrix} 8 & -1 \\ -4 & 2 \end{pmatrix}$$

(a) Find the value of det M

(1)

The triangle T has vertices at the points (4, 1), (6, k) and (12, 1), where k is a constant.

The triangle T is transformed onto the triangle T' by the transformation represented by the matrix M.

Given that the area of triangle T' is 216 square units,

(b) find the possible values of k.

(5)

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

Past Paper

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The parabola C has equation $y^2 = 4ax$, where a is a positive constant.

The point *S* is the focus of *C*.

The straight line *l* passes through the point *S* and meets the directrix of *C* at the point *D*.

Given that the y coordinate of D is $\frac{24a}{5}$,

(a) show that an equation of the line l is

$$12x + 5y = 12a$$

(2)

The point $P(ak^2, 2ak)$, where k is a positive constant, lies on the parabola C.

Given that the line segment SP is perpendicular to l,

(b) find, in terms of a, the coordinates of the point P.

(6)



7. $y^2 = 4ax$, $S(a,0)$, $D\left(-a, \frac{24a}{5}\right)$, $P(ak^2, 2ak)$ (a) $\frac{24a}{b} = \frac{24a}{b} = 0$, $\frac{24a}{b} = \frac{24a}{b} = 0$, $\frac{24a}{b} = \frac{24a}{b} = 0$, $\frac{24a}{b} = \frac{24a}{a-a}$ or $\frac{y-0}{24a} = \frac{x-a}{a-a}$ or $\frac{y-0}{24a} = \frac{x-a}{a-a}$ or $\frac{y-0}{24a} = \frac{x-a}{a-a}$ or $\frac{y-0}{5} = \frac{x-a}{a-a}$ or $\frac{y-0}{5} = \frac{x-a}{a-a}$ and $\frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$ M1 Can be un-simplified or simplified. ALT (a) $y = mx + c$ At S , $0 = ma + c$ At S , $0 = ma + c$ At S , $0 = ma + c$ At S , $S = -ma + c$ At S , $S = -ma + c$ At $S = \frac{12}{5}$, $S = \frac{12}{5}$ At $S = \frac$	Question Number	Scheme	Notes	Marks
$\frac{y-\frac{24a}{5}}{0-\frac{24a}{5}} = \frac{x-a}{a-a} \text{ or } \frac{y-0}{\frac{24a}{5}-0} = \frac{x-a}{-a-a}$ $\frac{y-\frac{24a}{5}}{0-\frac{24a}{5}} = \frac{x-a}{a-a} \text{ or } \frac{y-0}{\frac{24a}{5}-0} = \frac{x-a}{-a-a}$ $\frac{1: y-0=-\frac{12}{5}(x-a) \Rightarrow 5y=-12x+12a}{1: 12x+5y=12a (*)}$ $\frac{y=mx+c}{5}$ $At D, \frac{24a}{5}=-ma+c$ $\Rightarrow c=\frac{12a}{5}, m=-\frac{12}{5}$ $y=-\frac{12}{5}x+\frac{12a}{5}\Rightarrow 12x+5y=12a^*$ $\frac{y-1}{5}$ $y=\frac{2ak}{ak^2-a}\left\{=\frac{2k}{k^2-1}\right\}$ $m_t=-\left(\frac{ak^2-a}{2ak}\right) \text{ or } m_{SP}=-\frac{1}{(-\frac{12}{5})}\left\{=\frac{5}{12}\right\}$ $\cos\left(\frac{2k}{k^2-1}=\frac{5}{12}\Rightarrow\right) 24k=5k^2-5$ $\frac{y-3}{5}$ $\cos\left(\frac{2k}{k^2-1}=\frac{5}{12}\Rightarrow\right) (25a,10a)$ $\cos\left(\frac{2b}{2a}=\frac{5}{12a}\right) (25a,10a)$ $\cos\left(\frac{2b}{2a}=\frac{5}{12a}\right) (25a,10a)$ $\cos\left(\frac{2b}{2a}=\frac{5}{12a}\right) (25a,10a)$ $\cos\left(\frac{2b}{2a}=\frac{5}{12a}\right) (25a,10a)$ $\cos\left(\frac{2b}{2a}=\frac{5}{12a}\right) (25a,10a)$	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 $m_l = -\left(\frac{ak^2 - a}{2ak}\right) \text{ or } m_{SP} = -\frac{1}{(-\frac{12}{5})} \left\{ = \frac{5}{12} \right\}$ 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) $ 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 $\left\{\text{Correct 3TQ in terms of } k \text{ in any form.} \right\}$ M1 $\left\{\text{Correct 3TQ in terms of } k \text{ in any form.} \right\}$ M1 $\left\{\text{Correct 3TQ in terms of } k \text{ in any form.} \right\}$ M1 $\left\{\text{Correct 3TQ in terms of } k \text{ in any form.} \right\}$ M1 $\left\{\text{Correct 3TQ in terms of } k \text{ in any form.} \right\}$ Attempt to solve their 3TQ for k M1 $\left\{\text{Correct 3TQ in terms of } k \text{ in any form.} \right\}$	(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 \Longrightarrow \right\} (k - 5)(5k + 1) = 0 \Longrightarrow k = \dots $ Attempt to solve their 3TQ for k M1 $ \left\{ \text{As } k > 0, \text{ so } k = 5 \right\} \Longrightarrow (25a, 10a) $ Uses their k to find k M1 $ \left\{ \text{As } k > 0, \text{ so } k = 5 \right\} \Longrightarrow (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
$\{ \text{As } k > 0, \text{ so } k = 5 \} \Rightarrow (25a, 10a)$ (25a, 10a) A1		${5k^2 - 24k - 5 = 0 \Rightarrow} (k - 5)(5k + 1) = 0 \Rightarrow k =$		M1
(23u, 10u) A1		$\{ \text{As } k > 0, \text{ so } k = 5 \} \Rightarrow (25a, 10a)$		
		, , , , , ,	(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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8.	Prove by induction that		
	$f(n) = 2^{n+2} + 3^{2n+1}$		
	is divisible by 7 for all positive integers n .		
		(6)	

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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) (5(1) 7 (2k+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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9. (i) Given that

$$\frac{3w+7}{5} = \frac{p-4i}{3-i}$$
 where p is a real constant

(a) express w in the form a + bi, where a and b are real constants. Give your answer in its simplest form in terms of p.

(5)

Given that arg $w = -\frac{\pi}{2}$

(b) find the value of p.

(1)

(ii) Given that

$$(z+1-2i)^* = 4iz$$

find z, giving your answer in the form z = x + iy, where x and y are real constants.

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]
L	ı		

Mathematics FP1

Past Paper (Mark Scheme)

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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
	3 2 (3 2.)	At least one of either <i>x</i> or <i>y</i> are correct	A1
	So, $x = \frac{3}{5}$, $y = -\frac{2}{5}$ $\left\{ z = \frac{3}{5} - \frac{2}{5}i \right\}$	Both x and y are correct	A1
			[6]
			Total
			12