OXFORD AQA
INTERNATIONAL QUALIFICATIONS

INTERNATIONAL AS
FURTHER MATHEMATICS
FM1P1

Further Pure Mathematics 1

Mark scheme

Specimen

Version: 1.0

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Key to mark scheme abbreviations

M	Mark is for method
m	Mark is dependent on one or more M marks and is for method
A	Mark is dependent on M or m marks and is for accuracy
B	Mark is independent of M or m marks and is for method and accuracy
E	Mark is for explanation
ft	Follow through from previous incorrect result
CAO	Correct answer only
CSO	Correct solution only
AWFW	Anything which falls within
AWRT	Anything which rounds to
ACF	Any correct form
AG	Answer given
SC	Special case
oe	Or equivalent
NMS	No method shown
PI	Possibly implied
sf	Significant figure(s)
dp	Decimal place(s)
ISW	Ignore subsequent working

Mark Scheme Alignment

Marks in the Marks column will typically align with the relevant line of mathematics in the Answer column where the mark is awarded. If two or more marks are awarded for the same line of mathematics, then the Guidance column will give further details as to how each mark is awarded.

Square Brackets

Where square brackets appear in a line of the mark scheme where one or more marks are awarded, the mathematics inside the square bracket is not required for marks to be awarded. Instead, they are intended to be helpful to users of the mark scheme.

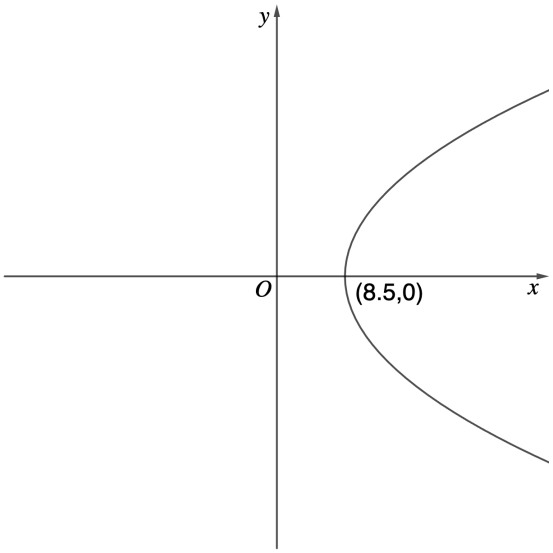
Exceptions to this include integration, vectors and matrices where square brackets carry a different mathematical meaning.

Q	Answer	Marks	Guidance
1(a)	$x^2 + y^2 + 3\mathrm{i}x - 3y + 3\mathrm{i}x + 3y - 9$	M1	**oe** Substitutes $z = x + \mathrm{i}y$ and $z^* = x - \mathrm{i}y$ and expands all brackets with no terms in i^2
	[Real part =] $x^2 + y^2 - 9$	A1	Correct real part.
	[Imaginary part =] $6x$	A1	Correct imaginary part.
	Subtotal	**3**	

Q	Answer	Marks	Guidance
1(b)	$[6x = 24 \Rightarrow x =]$ 4	B1ft	**ft** their imaginary part from **part (a)**.
	$16 + y^2 - 9 = 56$	M1	**oe** Substitutes their 4 into their real part from **part (a)** and sets equal to 56
	$[z =]$ $4 + 7\mathrm{i}$ $[z =]$ $4 - 7\mathrm{i}$	M1 A1	**M1**: At least one correct complex number z ignoring all others. **A1**: Both correct complex numbers z and no others.
	Subtotal	**4**	

	Question 1 Total	**7**	

Q	Answer	Marks	Guidance
2(a)	$(x-11)^2+y^2=(x-6)^2$	M1	**oe** Correctly equates distances
	$x^2-22x+121+y^2=x^2-12x+36$	M1	**oe** Expands their bracketed terms correctly.
	$y^2=5(2x-17)$	A1	**CAO**
	Subtotal	**3**	

Q	Answer	Marks	Guidance
2(b)		B1	Correct shape, symmetrical about the x-axis.
		B1ft	Correct coordinates of x-axis intercept. Condone given as a value. **ft** their $-\frac{c}{b}$
	Subtotal	**2**	

Q	Answer	Marks	Guidance
2(c)	$(y+2)^2=5(2x-9)$	B1 B1	**B1**: Correct left hand side. **B1**: Correct right hand side. **ACF**
	Subtotal	**2**	

	Question 2 Total	**7**	

Q	Answer	Marks	Guidance
3(a)	$\frac{5}{r+2}-\frac{5}{r+3}=\frac{5r+15-5r-10}{(r+2)(r+3)}$ $=\frac{5}{(r+2)(r+3)}$	B1	Must include one intermediate line of working before **AG** Must be convincingly shown.
	Subtotal	**1**	

Q	Answer	Marks	Guidance
3(b)	$\sum_{r=1}^{n}\frac{5}{(r+2)(r+3)}=\sum_{r=1}^{n}\left(\frac{5}{(r+2)}-\frac{5}{(r+3)}\right)$	B1	Writes as a sum of $\frac{5}{(r+2)}-\frac{5}{(r+3)}$
	$=\frac{5}{3}-\cancel{\frac{5}{4}}$ $+\cancel{\frac{5}{4}}-\cancel{\frac{5}{5}}$ $+...$ $+\cancel{\frac{5}{n+1}}-\cancel{\frac{5}{n+2}}$ $+\cancel{\frac{5}{n+2}}-\frac{5}{n+3}$	M1 M1	**M1**: Writes at least two pairs of fractions of the form $\frac{5}{(r+2)}-\frac{5}{(r+3)}$ **M1**: Writes at least three pairs of fractions of the form $\frac{5}{(r+2)}-\frac{5}{(r+3)}$ including the correct first pair, the correct last pair, and at least one other correct pair.
	$\frac{5}{3}-\frac{5}{n+3}$ or $\frac{5n+15-15}{3(n+3)}$ and $\frac{5n}{3(n+3)}$	A1	Unsimplified expression for the sum of the first and last terms before final answer given in the correct form. Must be convincingly shown.
	Subtotal	**4**	

Q	Answer	Marks	Guidance
3(c)	$\left[\sum_{r=1}^{\infty}\frac{5}{(r+2)(r+3)}=\right]\ \frac{5}{3}$	B1ft	**ft** their p and q from **part (b)**
	$\left[\sum_{r=1}^{300}\frac{5}{(r+2)(r+3)}=\right]\ \frac{5\times300}{3\times303}$	M1	**oe** Must use answer to **part (b)**. Correct method for finding $\sum_{r=1}^{300}\frac{5}{(r+2)(r+3)}$ Exact value $\frac{500}{303}$
	$\left[\frac{5}{3}-\frac{500}{303}=\right]\ \frac{5}{303}$	A1	**CAO**
	Subtotal	**3**	

	Question 3 Total	**8**	

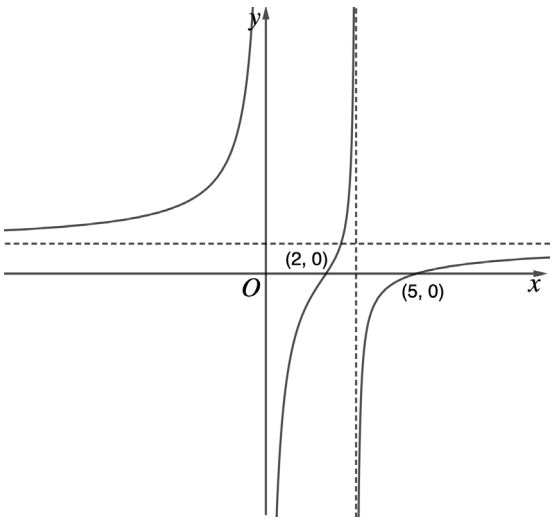
Q	Answer	Marks	Guidance
4(a)	$\left[\alpha+\beta=\right]\ \frac{5}{2}$	B1	oe
	$\left[\alpha\beta=\right]\ 2$	B1	CAO
	Subtotal	2	

Q	Answer	Marks	Guidance
4(b)	$\left[\alpha^3+\beta^3=(\alpha+\beta)^3-3\alpha\beta(\alpha+\beta)=\right]$ $\left(\frac{5}{2}\right)^3-3(2)\left(\frac{5}{2}\right)$	M1	oe Uses the correct identity for $\alpha^3+\beta^3$ with their values for $\alpha+\beta$ and $\alpha\beta$ correctly substituted.
	$\left[\alpha^3+\beta^3=\right]\ \frac{125}{8}-15$ and $\alpha^3+\beta^3=\frac{5}{8}$	A1	oe Further line of working with power and products evaluated before **AG** Must be convincingly shown.
	Subtotal	2	

Q	Answer	Marks	Guidance
4(c)	$\left[\alpha+\frac{4\alpha}{\beta^2}+\beta+\frac{4\beta}{\alpha^2}\right.$ $\left.=\alpha+\beta+\frac{4\left(\alpha^3+\beta^3\right)}{(\alpha\beta)^2}=\right]$ $\frac{5}{2}+\frac{4\left(\frac{5}{8}\right)}{4}$ or $\frac{5}{2}+\frac{5}{8}$	**M1**	**oe** Writing the sum of the roots in a suitable form with correct substitution. **ft** their $\alpha+\beta$ and $\alpha\beta$ from **part (a)**.
	$\left[\text{Sum of Roots}=\right]\ \frac{25}{8}$	**A1**	**oe**
	$\left[\alpha^2+\beta^2=(\alpha+\beta)^2-2\alpha\beta=\right]$ $\left(\frac{5}{2}\right)^2-2(2)$ or $\frac{25}{4}-4\quad\left[=\frac{9}{4}\right]$	**M1**	Uses correct identity for $\alpha^2+\beta^2$ with correct substitution. **ft** their $\alpha+\beta$ and $\alpha\beta$ from **part (a)**. **PI** by the correct value
	$\left[\left(\alpha+\frac{4\alpha}{\beta^2}\right)\left(\beta+\frac{4\beta}{\alpha^2}\right)\right.$ $\left.=\alpha\beta+\frac{4\left(\alpha^2+\beta^2\right)}{\alpha\beta}+\frac{16}{\alpha\beta}=\right]$ $2+\frac{4\left(\frac{25}{4}-4\right)}{2}+\frac{16}{2}$	**M1**	**oe** Writing the product of the roots in a suitable form with correct substitution. **ft** their $\alpha\beta$ from **part (a)** and their $\alpha^2+\beta^2$ provided it comes from a correct method.
	$\left[\text{Product of Roots}=\right]\ \frac{29}{2}$	**A1**	**oe**
	$8x^2-25x+116=0$	**M1 A1**	Any multiple of the coefficients but must be a three-term quadratic equation set equal to zero. **M1**:At least two correct terms. **A1**: Correct equation.
	Subtotal	**7**	

	Question 4 Total	**11**	

Q	Answer	Marks	Guidance
5(a)(i)	$x = 0$	**B1**	
	$x = 3$	**B1**	
	$y = 1$	**B1**	
	Subtotal	**3**	

Q	Answer	Marks	Guidance
5(a)(ii)		**M1 M1**	**M1**: At least two of any of the following shown on the graph. **M1**: At least four of any of the following shown on the graph. $y \to 1^-$ as $x \to \infty$ or $y \to 1^+$ as $x \to -\infty$ or $y \to -\infty$ as $x \to 3^+$ or $y \to \infty$ as $x \to 3^-$ or $y \to -\infty$ as $x \to 0^+$ or $y \to \infty$ as $x \to 0^-$
		A1	All three sections drawn correctly showing correct asymptotic behaviour.
	$(2, 0)$ and $(5, 0)$	**B1**	Correct coordinates of both x-intercepts. Allow given as values.
	Subtotal	**4**	

Q	Answer	Marks	Guidance
5(b)	$0 < x < 2$ or $3 < x < 5$	M1 A1	**M1**: At least one correct interval. **A1**: Both correct intervals
	Subtotal	**2**	

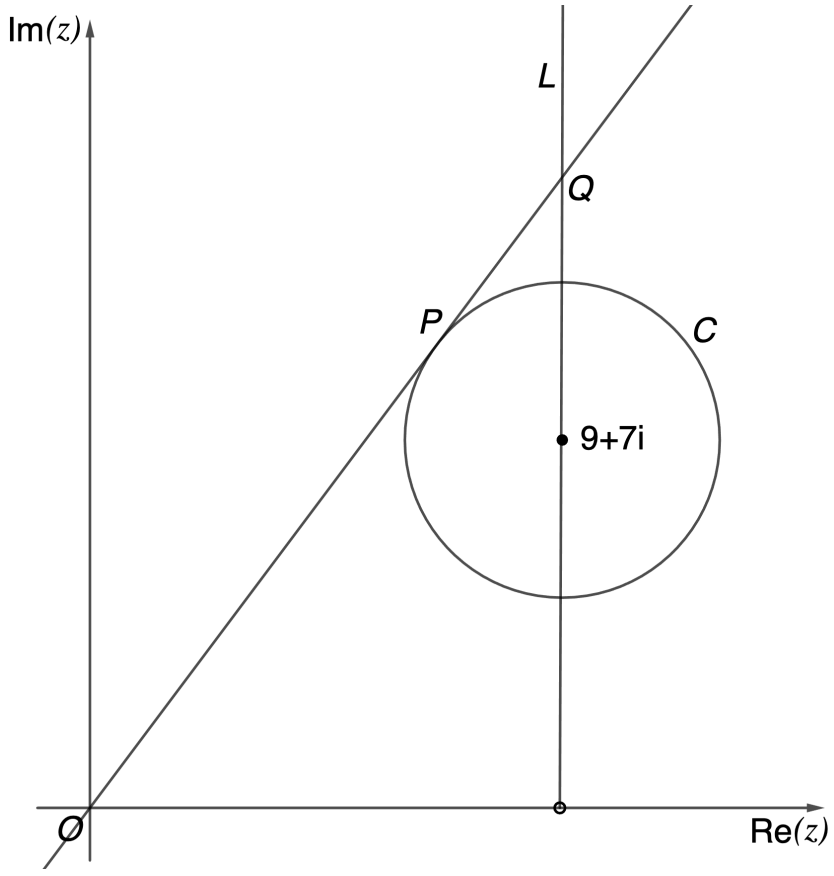
	Question 5 Total	**9**	

Q	Answer	Marks	Guidance
6(a)	$\left[\sum_{r=1}^{2n} 4r\left(r^2-3r+2\right)=\right]$ $4\sum_{r=1}^{2n} r^3 - 12\sum_{r=1}^{2n} r^2 + 8\sum_{r=1}^{2n} r$	M1	Splitting up the sum into three separate sums.
	$\left[\sum_{r=1}^{2n} 4r\left(r^2-3r+2\right)=\right]$ $4\left(\frac{1}{4}(2n)^2\right)(2n+1)^2$ $-12\left(\frac{1}{6}(2n)\right)(2n+1)(4n+1)$ $+8\left(\frac{1}{2}(2n)\right)(2n+1)$ or $4n^2(2n+1)^2 - 4n(2n+1)(4n+1)$ $+8n(2n+1)$	M1 A1	**oe** Substitutes $2n$ into the correct summation formulae. **M1**: Correct expression condoning one error. **A1**: Correct expression.
	$\left[\sum_{r=1}^{2n} 4r\left(r^2-3r+2\right)=\right]$ $4n(2n+1)\left(\left(n(2n+1)\right)-(4n+1)+2\right)$	M1	**oe** Takes out a factor of $4n(2n+1)$ Must be working with the correct expression.
	$\left[\sum_{r=1}^{2n} 4r\left(r^2-3r+2\right)=\right]$ $4n(2n+1)\left(2n^2-3n+1\right)$	A1	Correct product of two linear factors and a three-term quadratic factor.
	$\left[\sum_{r=1}^{2n} 4r\left(r^2-3r+2\right)\right.$ $\left.=4n(2n+1)(2n-1)(n-1)=\right]$ $4n\left(4n^2-1\right)(n-1)$	A1	Final answer must be in the correct form. Must be convincingly shown.
	Subtotal	**6**	

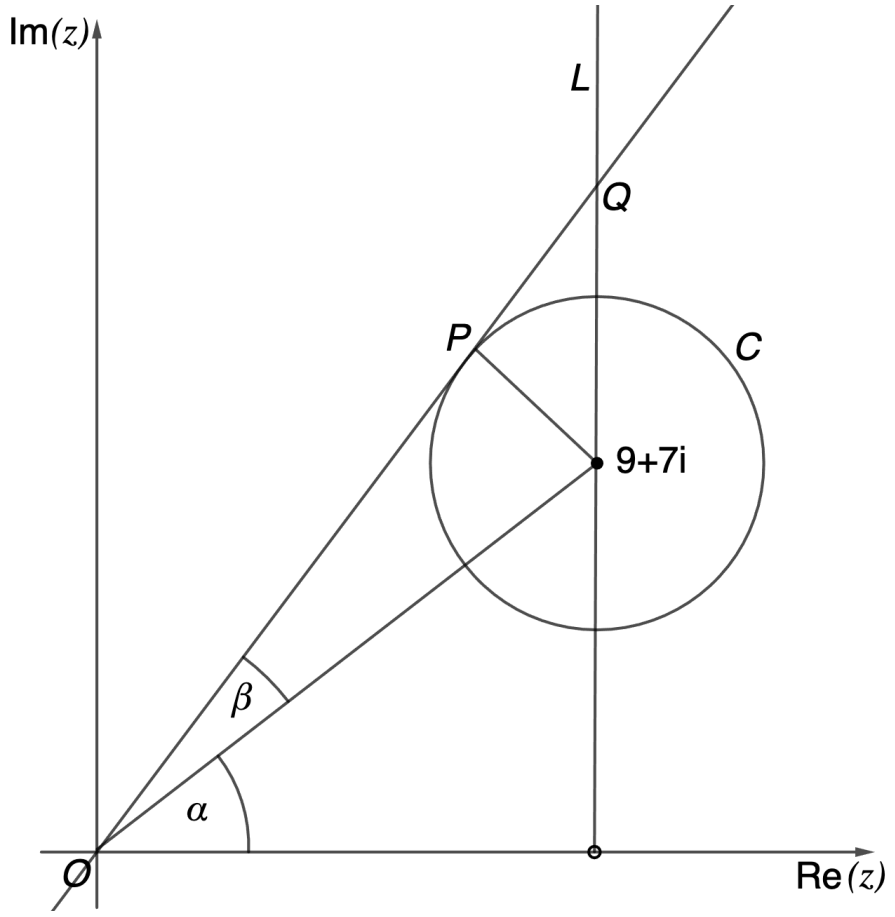
Q	Answer	Marks	Guidance
6(b)	$\left[\sum_{r=1}^{18} 4r\left(r^2-3r+2\right)=\right]$ $4(9)\left(4(9)^2-1\right)(9-1)$	**M1**	**oe** Substitutes $n=9$ into their final answer in **part (a)**
	$\left[\sum_{r=1}^{18} 4r\left(r^2-3r+2\right)=\right]$ 93 024	**A1**	**CAO** **Part (a)** not used is awarded zero marks.
	Subtotal	**2**	

	Question 6 Total	**8**	

Q	Answer	Marks	Guidance
7(a)	$9+7\mathrm{i}$	B1	
	Subtotal	1	

Q	Answer	Marks	Guidance
7(b)	*L* drawn correctly	B1	Condone no indication that the end point is not included, but must not pass below the real axis.
	OP drawn correctly	B1	No need to extend beyond *O* or *P*
	Q marked correctly	B1ft	**ft** their line *OP* but must have the correct half-line *L*
			
	Subtotal	3	

Q	Answer	Marks	Guidance
7(c)	$[\tan\alpha =]\ \frac{7}{9}$	B1	
	$\left[\sin\beta = \frac{3}{\sqrt{130}} \Rightarrow \tan\beta = \right]\ \frac{3}{11}$	B1	Deduces value of $\tan\beta$
	$[\arg z =]\quad \alpha + \beta$	M1	
	$\left[\tan(\alpha+\beta) = \right]\ \frac{4}{3}$	A1	Deduces correct value of $\tan(\alpha+\beta)$
	$[z =]\quad 9 + 9\tan(\alpha+\beta)\mathrm{i}$	M1	
	$[z =]\quad 9 + 12\mathrm{i}$	A1	



	Subtotal	**6**	

	Question 7 Total	**10**	