OCR
Oxford Cambridge and RSA

Wednesday 24 May 2017 – Morning

AS GCE MATHEMATICS

4722/01 Core Mathematics 2

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4722/01
- List of Formulae (MF1)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Do **not** write in the barcodes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question or is clearly appropriate.

INFORMATION FOR CANDIDATES

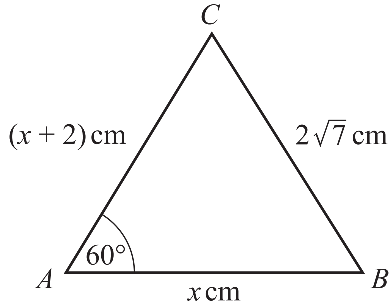
This information is the same on the Printed Answer Book and the Question Paper.

- The number of marks is given in brackets **[ ]** at the end of each question or part question on the Question Paper.
- **You are reminded of the need for clear presentation in your answers.**
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

INSTRUCTIONS TO EXAMS OFFICER/INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

1



The diagram shows triangle ABC, with $AB = x\,\text{cm}$, $AC = (x+2)\,\text{cm}$, $BC = 2\sqrt{7}\,\text{cm}$ and angle $CAB = 60°$.

(i) Find the value of x. **[4]**

(ii) Find the area of triangle ABC, giving your answer in an exact form as simply as possible. **[2]**

2 **(i)** Use the trapezium rule, with 4 strips each of width 0.2, to find an estimate for $\int_0^{0.8} \cos x \, dx$, where x is in radians. Give your answer correct to 3 significant figures. **[4]**

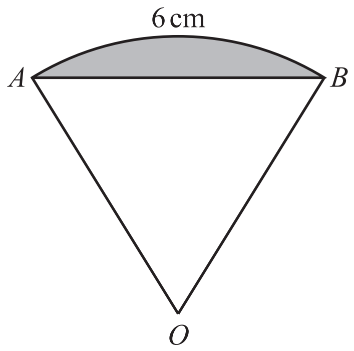
(ii) Explain, with the aid of a sketch, why the value from part **(i)** is an under-estimate. **[2]**

3 **(i)** Find and simplify the first four terms in the expansion of $\left(1+\frac{1}{2}x\right)^8$ in ascending powers of x. **[4]**

(ii) Hence find the coefficient of y^2 in the expansion of $\left(1+\frac{1}{2}(y+y^2)\right)^8$. **[2]**

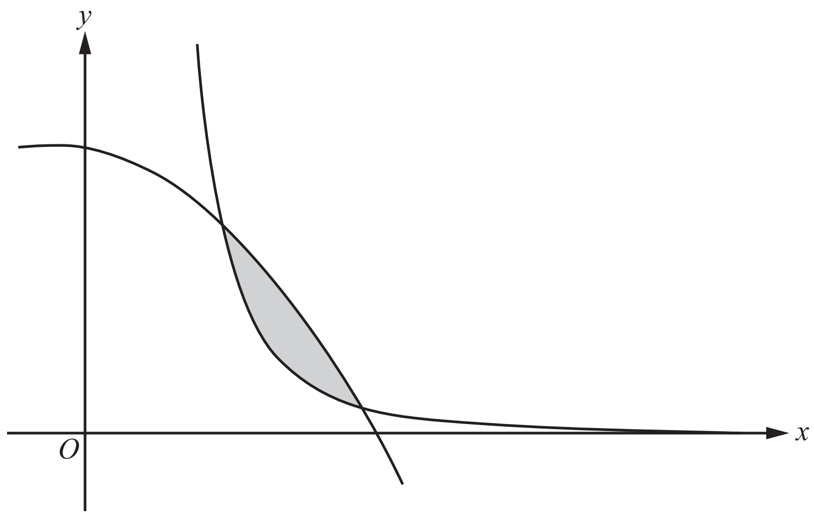
4 The gradient of a curve is given by $\frac{dy}{dx} = 5x(\sqrt{x}-2)$ and the curve passes through the point (4, 11). Find the equation of the curve. **[6]**

5



The diagram shows a sector AOB of a circle with centre O. The length of the arc AB is 6 cm and the area of the sector AOB is $24\,\text{cm}^2$. Find the area of the shaded segment enclosed by the arc AB and the chord AB, giving your answer correct to 3 significant figures. **[6]**

6



The diagram shows parts of the curves $y = 11 - x - 2x^2$ and $y = \dfrac{8}{x^3}$. The curves intersect at (1, 8) and (2, 1). Use integration to find the exact area of the shaded region enclosed between the two curves. **[7]**

7 **(a)** Use logarithms to solve the equation $3^{x+1} = 2^{500}$, giving your answer correct to 3 significant figures. **[4]**

(b) **(i)** Show that the equation $\log_2(y+1) - 1 = 2\log_2 x$ can be written in the form $y = ax^2 + b$, where a and b are integers. **[4]**

(ii) Hence solve the simultaneous equations

$$\log_2(y+1) - 1 = 2\log_2 x, \qquad \log_2(y - 10x + 14) = 0.$$ **[4]**

8 **(a)** The seventh term of an arithmetic progression is equal to twice the fifth term. The sum of the first seven terms is 84. Find the first term. **[5]**

(b) The seventh term of a geometric progression is equal to twice the fifth term. The sum of the first seven terms is 254 and the terms are all positive. Find the first term, showing that it can be written in the form $p + q\sqrt{r}$ where p, q and r are integers. **[6]**

9 The cubic polynomial $f(x)$ is defined by $f(x) = 4x^3 + 9x - 5$.

(i) Show that $(2x-1)$ is a factor of $f(x)$ and hence express $f(x)$ as the product of a linear factor and a quadratic factor. **[4]**

(ii) (a) Show that the equation

$$4\sin 2\theta \cos 2\theta + \frac{5}{\cos 2\theta} = 13\tan 2\theta$$

can be expressed in the form

$$4\sin^3 2\theta + 9\sin 2\theta - 5 = 0.$$ **[4]**

(b) Hence solve the equation

$$4\sin 2\theta \cos 2\theta + \frac{5}{\cos 2\theta} = 13\tan 2\theta$$

for $0 \leqslant \theta \leqslant 2\pi$. Give each answer in an exact form. **[4]**

END OF QUESTION PAPER

Question			Answer	Marks	Guidance	
1	(i)		$(2\sqrt{7})^2 = x^2 + (x+2)^2 - 2x(x+2)\cos 60$ $x^2 + 2x - 24 = 0$ $(x+6)(x-4) = 0$ $x = 4$	M1	Attempt use of correct cosine rule	Must be attempt to use correct rule but allow BOD on lack of brackets eg $2\sqrt{7}^{\ 2}$ not $(2\sqrt{7})^2$, even if subsequently 14, and the same for the terms involving x Allow omission of a square sign when substituting as long as correct formula has been seen No need to evaluate cos60 for M1 Evaluating in radian mode (-0.952) still can get M1 as long as cos60 seen first
				A1	Obtain correct 3 term quadratic	Must be simplified to three terms but not necessarily all on one side of the equation
				M1	Attempt to solve 3 term quadratic equation	See additional guidance for valid methods
				A1	Obtain $x = 4$ only	Must be from a correct solution of a correct quadratic, though only the positive root may ever be seen Could draw attention to required root by giving both answers and then eg underlining $x = 4$ A0 if $x = -6$ still present
				[4]		If the other root is stated, before being discarded, it must have been $x = -6$
	(ii)		$\frac{1}{2} \times 4 \times 6 \times \sin 60$ $= 6\sqrt{3}$	M1	Attempt area of the triangle, using their x	Must be using correct formula, including $^1/_2$ Allow equiv methods, such as $^1/_2\ bh$ as long as valid attempt at b and h Must be using a positive, numerical, value of x from **(i)**
				A1	Obtain $6\sqrt{3}$	Must be given as simplified surd No ISW if then given as decimal, unless the exact value is indicated as the final answer (underlined etc)
				[2]		

Question			Answer	Marks	Guidance	
2	(i)		$0.5\times0.2\{\cos0 + \cos0.8 + 2(\cos0.2 + \cos0.4 + \cos0.6)\}$ $= 0.715$	B1	State the 5 correct y-values, and no others	B0 if other y-values also found (unless not used) Allow for exact values seen, even if subsequent error made (including evaluating in degree mode) Allow decimal equivs (2dp or better) (1, 0.980, 0.921, 0.825, 0.697); if using 2dp then allow 0.7 rather than 0.70 for final y value
				M1*	Attempt to find area between $x = 0$ and $x = 0.8$, using $k\{y_0 + y_n + 2(y_1 + ... + y_{n-1})\}$	Correct placing of y-values required y-values may not necessarily be correct, but must be from attempt at using correct x-values in $y = \cos x$ (in radian mode or degree mode) The 'big brackets' must be seen, or implied by later working Could be implied by stating general rule in terms of y_0 etc, as long as these have been attempted elsewhere and clearly labelled Could use other than 4 strips as long as of equal width (but M0 for just one strip)
				M1d*	Use $k = 0.5 \times 0.2$ soi	Or $k = 0.5 \times h$, where h is consistent with the number of strips used
				A1	Obtain 0.715, or better	Allow answers rounding to 0.715 if >3sf Using 4 separate trapezia can get full marks Must see evidence of trapezium rule or 0/4 (integration gives 0.717 to 3sf) Working in degrees: B1 if exact values seen (ie cos0.2 etc), but B0 if straight into decimals M1 M1 is then possible as long as it is clear where each value is being placed $0.5\times0.2\ \{1.00 + 1.00 + 2(1.00 + 1.00 + 1.00)\} = 0.800$ will be 0/4 unless more detail shown
				[4]		

Question			Answer	Marks	Guidance	
	(ii)		Graph of $y = \cos x$, with 4 trapezia drawn	B1	Correct $y = \cos x$ graph, with exactly 4 trapezia of roughly equal width	Trapezia must be plausibly [0, 0.8], allow BOD as long as final trapezium ends before $^{\pi}/_{2}$ Curve may be shown beyond $x = 0.8$, but B0 if clearly of the incorrect shape beyond $x = 0.8$ No need for scale on either axis Exactly four trapezia must be shown, of roughly equal widths, with top vertices on the curve.
			Tops of the trapezia are below the curve	B1 **[2]**	Any valid explanation	Not dependent on previous B1 Must refer to the tops of the trapezia so B0 for 'trapezia are below curve' (ie 'top' not used) Allow 'trapezium' rather than 'trapezia' Concave / convex is B0 B0 if comparing to exact area B1 for decreasing gradient (but B0 for decreasing curve) Candidates could also use their diagram as part of their explanation – as long as there was an intention to draw trapezia then they are eligible for the second B1 even if B0 for the diagram. This could include a single trapezium (even if labelled 0 – 0.8), several trapezia whose tops are collinear, an incorrect $y = \cos x$ graph (including $y = \sin x$) and similar. Use of rectangles to support their explanation however is B0. They could shade gaps on their diagram but some text also required B0 for 'some area not calculated' unless clear which area - could be described or shaded ISW any irrelevant comments, but B0 if contradictory comments

Question			Answer	Marks	Guidance	
3	(i)		$1 + 4x + 7x^2 + 7x^3$	B1	Obtain $1 + 4x$	Must be 1, not 1^8 Must be $4x$ not unsimplified equiv Allow separate terms not linked by '+' eg 1, $4x$
				M1	Attempt at least one more term - product of correct binomial coeff and power of $^1/_2\, x$	Powers of $^1/_2\, x$ must be consistent with the binomial coeff being used Binomial coeff must be numerical, so $^8C_2$ is not yet sufficient Allow M1 if powers only applied to x and not ½
				A1	Obtain $7x^2$	Coeff must be simplified As part of sum, or part of list
				A1	Obtain $7x^3$	Coeff must be simplified As part of sum, or part of list ISW any attempt to 'simplify' **If expanding brackets:** Mark as above, but must consider all 8 brackets for the M mark (allow irrelevant terms to be discarded)
				[4]		
	(ii)		$4(y + y^2) + 7(y + y^2)^2$ Hence coefficient of y^2 is 11	M1	Attempt to use $x = y + y^2$ in their expansion from **(i)**	Replace x with $y + y^2$ in both relevant terms and attempt expansion, including relevant numerical coeffs from **(i)** Allow M1 if using their attempt at a 'simplified' expansion Could instead attempt a new expansion - must use correct binomial coeffs and powers of $^1/_2(y + y^2)$
				A1FT	Obtain coefficient of 11 (or $11y^2$), FT their **(i)**	Ignore terms involving powers other than y^2 The FT is on their $1 + 4x + 7x^2 + 7x^3$, not a multiple of this as a result of any attempt to 'simplify'
				[2]		

Question			Answer	Marks	Guidance	
4			$\frac{dy}{dx} = 5x^{\frac{3}{2}} - 10x$	B1	Expand bracket to obtain correct expression	Each term must be of form kx^n, so $5x\sqrt{x}$ is not sufficient
			$y = 2x^{\frac{5}{2}} - 5x^2 + c$	M1	Attempt integration	M0 if bracket not expanded first M1 can still be gained for integrating an incorrect expansion as long as there are two terms For an 'integration attempt' there must be an increase in power by 1 for both terms
				A1	Obtain at least one correct term	Allow unsimplified coeffs
				A1	Obtain fully correct expression (allow no $+c$)	Allow unsimplified coeffs
			$11 = 64 - 80 + c \Rightarrow c = 27$	M1	Attempt to find c, using (4, 11)	There must have been a clear attempt at integration, but can follow M0 eg if the bracket was not expanded first Need to get as far as actually attempting c M1 could be implied by eg 11 = 64 - 80 followed by an attempt to include a constant to balance the equation M0 if no + c seen or implied M0 for $x = 11$, $y = 4$ Allow a slip when substituting, as long as it is clear that use of $x = 4$, $y = 11$ is intended
			$y = 2x^{\frac{5}{2}} - 5x^2 + 27$	A1	Obtain fully correct equation, including $y = ...$	Coefficients now need to be simplified Must be an equation ie $y = ...$, so A0 for 'f(x) = ...' or 'equation = ...' ISW an incorrect attempt to further simplify the equation
				[6]		NB this question can also be done using integration by parts – 4/4 for correct integral (but no partial credit) and then M1A1 as per MS

Question			Answer	Marks	Guidance	
5			$r\theta = 6$ $½r^2\theta = 24$ $½r \times 6 = 24$ $r = 8$, $\theta = 0.75$ segment area $= 24 - ½ \times 8^2 \times \sin 0.75$ $= 2.19$	B1*	State $r\theta = 6$	Or exact equiv from using a fraction of the circle
				B1*	State $½r^2\theta = 24$	Or exact equiv from using a fraction of the circle Allow B1 for $^1/_2\, r \times \text{arc} = 24$ Stating both $½r^2\theta = 24$ and $^1/_2 r^2\sin\theta = 24$ is B0 unless only the correct equation is subsequently used B1 B1 can be implied by a correct equation in a single variable
				M1d*	Attempt to solve simultaneously to find r or θ	As far as attempting r or θ, using a valid method (but allow slips) Must be using the two correct equations in r and θ
				A1	Obtain $r = 8$, $\theta = 0.75$ (aef)	Both values required
				M1	Attempt area of segment	24 – area of triangle, using $^1/_2 r^2\sin\theta$ or equiv Allow if evaluated in degree mode (gives 23.58) Allow M1 for attempting $^1/_2 r^2(\theta - \sin\theta)$ with their r and θ, even if this does not give area of sector as 24
				A1	Obtain 2.19, or better	Allow final answer in range [2.187, 2.188] if > 3sf Could use variables other than r and θ
				[6]		**Alt method for working in degrees** B1 - state $^{\theta}/_{360} \times 2\pi r = 6$ B1 - state $^{\theta}/_{360} \times \pi r^2 = 24$ M1 - attempt to solve simultaneously A1 - obtain $r = 8$, $\theta = 43.0^{\circ}$ or better (42.97...) M1 - attempt area of segment NB using $^1/_2 r^2(\theta - \sin\theta)$ with θ in degrees is M0 as incorrect attempt at area of sector A1 - obtain 2.19 or better

Question			Answer	Marks	Guidance	
6			$\int(11 - x - 2x^2)\mathrm{d}x = 11x - \frac{1}{2}x^2 - \frac{2}{3}x^3$	M1	Attempt integration of $11 - x - 2x^2$	Increase in power by 1 for at least 2 terms
			$\int 8x^{-3}\mathrm{d}x = -4x^{-2}$	A1	Obtain $11x - \frac{1}{2}x^2 - \frac{2}{3}x^3$	Obtain correct integral
			$(22 - 2 - \frac{16}{3}) - (11 - \frac{1}{2} - \frac{2}{3}) = \frac{29}{6}$	M1	Attempt integration of $8x^{-3}$	Integrate to kx^{-2}
			$(-1) - (-4) = 3$	A1	Obtain $-4x^{-2}$	Allow unsimplified coeff
			$\frac{29}{6} - 3 = \frac{11}{6}$	M1	Use limits of $x = 1, 2$	In both integrals Must follow clear attempt at integration Must be F(2) – F(1) ie correct order and subtraction
				M1	Attempt correct method to find shaded area (at any point)	M0 if incorrect order of subtraction, even if $\frac{11}{6}$ subsequently appears as final answer M1 can follow M0 for use of limits
				A1	Obtain $\frac{11}{6}$, or exact equiv	A0 for decimal answer unless clearly a recurring decimal (but not eg 1.833...) ISW if $\frac{11}{6}$ seen but then followed by eg 1.83
				[7]		Answer only is 0/7 - need to see evidence of integration, but use of limits does not need to be explicit
						Alternative MS for subtracting first: M1 - attempt subtraction in correct order M1 - attempt integration of $\pm(11 - x - 2x^2)$ A1 - obtain $\pm(11x - \frac{1}{2}x^2 - \frac{2}{3}x^3)$, signs must be consistent with their subtraction M1 - attempt integration of $\pm 8x^{-3}$ A1 - obtain $\mp 4x^{-2}$, sign must be consistent with their subtraction M1 - correct use of limits in entire integral A1 - obtain $\frac{11}{6}$

Question			Answer	Marks	Guidance	
						Ignore sight of $11 - x - 2x^2 = 8x^{-3}$ prior to subtraction occurring Adding functions prior to integration will get max of 5 marks - M0M1A1M1A1M1A0 (**Alt MS**) – to give same credit as integrating separately, using limits and then adding Multiplying through by x^3 prior to integration can get M1 for use of limits, and possibly M1 if subtraction happens before multiplying through
7	**(a)**		$(x + 1)\log 3 = 500\log 2$ $x + 1 = 315.46$ $x = 314$	M1	Introduce logs and drop power(s)	Any base (or no explicit base) as long as consistent If using logs to any base other than 2 or 3, then both powers must be dropped Allow BOD if $x + 1$ is not in brackets
				A1	Obtain correct linear equation	aef eg $x + 1 = 500\log_3 2$ Brackets must now be explicit, or implied by a later correct equation
				M1	Attempt to find x	Correct order of operations and correct operations, so M0 for eg $x = 500\log_3 2 + 1$
				A1	Obtain 314, or better	Allow answer in range [314.4, 314.5] if > 3sf ISW subsequent incorrect rounding once more accurate answer has been seen
				[4]		Answer only, or T&I, is 0/4 Writing 2 as $3^{0.6309}$ with no evidence of use of logs to find the index is 0/4

Question			Answer	Marks	Guidance	
	(b)	(i)	$\log_2(y + 1) - \log_2 2 = \log_2 x^2$	B1	$2\log_2 x = \log_2 x^2$	Used correctly at any point, even if equation is no longer fully correct Allow no base
			$\log_2(^{y+1}/_2) = \log_2 x^2$			
			$y + 1 = 2x^2$	M1	Correctly combine at least two log terms	Could be the 2 log terms in the given equation, or could involve $\log_2 2$ The terms being combined must be correct, even if an error has occurred elsewhere in the equation M0 for incorrect method eg $^{\log(y+1)}/_{\log 2}$ even if it then becomes $\log(^{y+1}/_2)$
			$y = 2x^2 - 1$ ie $a = 2$, $b = -1$			
				A1	Correct equation with at least two terms combined	Equation of form $\log_2 f(x, y) = k$ or $\log_2 f(y) = \log_2 g(x)$ Condone no base on the logs
				A1	Obtain $y = 2x^2 - 1$	Correct equation required, but no need for explicit statement of $a = 2$, $b = -1$
				[4]		
		(ii)	$y - 10x + 14 = 1$	B1FT	Correct equation - www	State correct equation - aef not involving logs Allow FT on an incorrect equation from **(i)** if the substitution occurs before the log is removed ie B1FT is awarded for their $(ax^2 + b) - 10x + 14 = 1$
			$2x^2 - 1 - 10x + 14 = 1$			
			$2x^2 - 10x + 12 = 0 \Rightarrow x^2 - 5x + 6 = 0$			
			$(x - 2)(x - 3) = 0$ $x = 2$, $x = 3$ $y = 7$, $y = 17$	M1*	Attempt to eliminate a variable	Using their $y - 10x + 14 = 1$ with their answer from **(i)**, which must be of the form $y = ax^2 + b$ oe, to obtain an equation in a single variable not involving logs M1 can still be awarded if the method to remove logs is not correct
				M1d*	Attempt to solve 3 term quadratic	See additional guidance for valid methods
				A1	Obtain both correct x,y pairs	Clear indication of which values are paired together - could be implied by eg $y = 2 \times 2^2 - 1 = 7$ A0 if $y = 2x^2 - 1$ was obtained fortuitously in part **(i)**
				[4]		

Question			Answer	Marks	Guidance	
8	(a)		$a + 6d = 2(a + 4d)$ $a = -2d$ ${}^{7}/_{2}(2a + 6d) = 84$ ${}^{7}/_{2}(2a - 3a) = 84$ $a = -24$	M1	Attempt $u_7 = 2u_5$	Using correct $u_n = a + (n-1)d$
				A1	Obtain $a = -2d$ or equiv	Obtain correct simplified equation, with like terms combined
				B1	State ${}^{7}/_{2}(2a + 6d) = 84$	Or equiv, including unsimplified
				M1	Attempt to solve simultaneously	As far as attempting a or d Must be solving two equations in a and d, from attempt at $u_7 = 2u_5$ and attempt at S_7 (but could be from incorrect formulae eg $u_n = a + nd$)
				A1	Obtain $a = -24$	If d is also given then it must be correct ($d = 12$) Could use variables other than a and d
				[5]		

Question			Answer	Marks	Guidance	
	(b)		$r^2 = 2$ hence $r = \sqrt{2}$	B1	State $r = \sqrt{2}$ www	B0 if from $ar^7 = 2ar^5$ (but then allow all of the remaining marks) Allow decimal value (1.41) Allow B1 for $r = \pm\sqrt{2}$
			$\frac{a(1-\sqrt{2}^7)}{1-\sqrt{2}} = 254$	M1	Attempt $S_7 = 254$	Must be correct formula, using their numerical r, which could be exact or a decimal value Must also equate to 254
			$a = \frac{254(1-\sqrt{2})}{1-8\sqrt{2}}$	A1	Rearrange to obtain correct numerical expression for a aef	Must be in an exact form, but could involve $(\sqrt{2})^7$ or $\sqrt{128}$ rather than $8\sqrt{2}$ Ignore second value for a from using $r = -\sqrt{2}$
			$a = \frac{254(1-\sqrt{2})(1+8\sqrt{2})}{(1-8\sqrt{2})(1+8\sqrt{2})}$	B1	Use $(\sqrt{2})^7 = 8\sqrt{2}$ soi	Equation may no longer be fully correct
			$a = \frac{254(-15+7\sqrt{2})}{-127}$	M1	Attempt to rationalise denominator	Must be using $r = \sqrt{2}$ only Must be explicit evidence of rationalising Could use $(1 + (\sqrt{2})^7)$ or $(1 + \sqrt{128})$ Allow M1 if denominator now incorrect, as long as of form $\pm(1 - k\sqrt{2})$ or equiv M0 if rationalising $1 - \sqrt{2}$ only (ie before making a the subject)
			$a = 30 - 14\sqrt{2}$	A1	Obtain correct value in surd form	Allow any exact answer in form $p + q\sqrt{r}$ A0 if additional answer from using $r = -\sqrt{2}$ A0 if final answer results from subsequent attempt to simplify eg $a = 15 - 7\sqrt{2}$ (ie no ISW)
				[6]		Could use variables other than a and r If $a = 30 - 14\sqrt{2}$ obtained, but no evidence of dealing with $(\sqrt{2})^7$ or rationalising denominator then maximum of B1 M1 A1 ie 3 marks (as the given form has not been 'shown')

Question			Answer	Marks	Guidance	
9	**(i)**		$f(^1/_2) = {}^1/_2 + {}^9/_2 - 5 = 0$ $f(x) = (2x - 1)(2x^2 + x + 5)$	B1	Confirm $f(^1/_2) = 0$, with detail shown	$4(^1/_2)^3 + 9(^1/_2) - 5 = 0$ is sufficient B0 for just $f(^1/_2) = 0$ No conclusion needed If using division to justify then must draw attention to the zero remainder
				M1	Attempt complete division or equiv	Must be dividing by $(2x - 1)$ Must be complete method - ie all 3 terms attempted Long division - must subtract lower line (allow one slip) Inspection - expansion must give at least three correct terms of the cubic Coefficient matching - must be valid attempt at all coeffs of quadratic, considering all relevant terms each time Synthetic division - must be using 0.5 (not – 0.5) and adding within each column (allow one slip); expect to see $\begin{array}{c\|cccc} 0.5 & 4 & 0 & 9 & -5 \\ & & 2 & 1 & \\ \hline & 4 & 2 & 10 & \end{array}$
				A1	Obtain correct quotient	Allow $4x^2 + 2x + 10$ from dividing by $x - {}^1/_2$
				A1	Obtain $(2x - 1)(2x^2 + x + 5)$	Must be written as a product Allow $(x - {}^1/_2)(4x^2 + 2x + 10)$ ISW any attempt to write as 3 linear factors, or to find roots
				[4]		

Question			Answer	Marks	Guidance	
	(ii)	(a)	$4\sin 2\theta\cos 2\theta + \frac{5}{\cos 2\theta} = \frac{13\sin 2\theta}{\cos 2\theta}$	B1	Use $\tan 2\theta = \frac{\sin 2\theta}{\cos 2\theta}$ or $\tan 2\theta\cos 2\theta = \sin 2\theta$	Must be explicit, and correct notation when used Allow even if errors elsewhere in equation
			$4\sin 2\theta\cos^2 2\theta + 5 = 13\sin 2\theta$ $4\sin 2\theta(1 - \sin^2 2\theta) + 5 = 13\sin 2\theta$	B1	Correct method to remove fraction(s)	Any correct equation seen no longer containing fractions (allow recovery from a slip in notation)
			$4\sin 2\theta - 4\sin^3 2\theta + 5 = 13\sin 2\theta$	B1	Use $\cos^2 2\theta = 1 - \sin^2 2\theta$	Must be explicit, and correct notation when used Allow even if errors elsewhere in equation
			$4\sin^3 2\theta + 9\sin 2\theta - 5 = 0$	B1	Obtain correct equation, from correct working	Must be correct notation throughout Dependent on B1 B1 B1 awarded
				[4]		**NB - must annotate answer space at top of pg12**
		(b)	$(2\sin 2\theta - 1)(2\sin^2 2\theta + \sin 2\theta + 5) = 0$ $\sin 2\theta = \frac{1}{2}$	B1	State that $\sin 2\theta = \frac{1}{2}$ oe	Could just be stated, or implied by later method
			$2\theta = \frac{1}{6}\pi, \frac{5}{6}\pi, \frac{13}{6}\pi, \frac{17}{6}\pi$	M1	Attempt to solve $\sin 2\theta = \pm\frac{1}{2}$ to find at least one root	Correct order of operations ie $\frac{1}{2}$ ($\sin^{-1}\frac{1}{2}$) Allow M1 if angle(s) found in degrees (15°, 75° etc)
			$\theta = \frac{1}{12}\pi, \frac{5}{12}\pi, \frac{13}{12}\pi, \frac{17}{12}\pi$	A1	Obtain at least 2 correct roots	Must be in radians, and given in an exact form Allow recurring decimals, or mixed numbers
				A1	Obtain 4 correct roots	Must be in radians, and given in an exact form Allow recurring decimals, or mixed numbers ISW any angles that come from an incorrect quadratic quotient, or an incorrect attempt to find the roots of the quadratic quotient A0 if any extras in range $[0, 2\pi]$ that are not clearly from their quadratic roots
				[4]		

APPENDIX 1