UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

9709 MATHEMATICS

9709/32

Paper 3, maximum raw mark 75

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

• Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

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Mark Scheme Notes

Marks are of the following three types:

- M Method mark, awarded for a valid method applied to the problem. Method marks are not lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.
- A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated method mark is earned (or implied).
- B Mark for a correct result or statement independent of method marks.
- When a part of a question has two or more "method" steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly when there are several B marks allocated. The notation DM or DB (or dep*) is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.
- The symbol √ implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only. A and B marks are not given for fortuitously "correct" answers or results obtained from incorrect working.
- Note: B2 or A2 means that the candidate can earn 2 or 0.
 B2/1/0 means that the candidate can earn anything from 0 to 2.

The marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.
- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking *g* equal to 9.8 or 9.81 instead of 10.

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The following abbreviations may be used in a mark scheme or used on the scripts:

AEF	Any Equivalent Form (of answer is equally acceptable)
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
BOD	Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)
CAO	Correct Answer Only (emphasising that no "follow through" from a previous error is allowed)
CWO	Correct Working Only – often written by a 'fortuitous' answer
ISW	Ignore Subsequent Working
MR	Misread
PA	Premature Approximation (resulting in basically correct work that is insufficiently accurate)
sos	See Other Solution (the candidate makes a better attempt at the same question)
SR	Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)

Penalties

- MR −1 A penalty of MR −1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become "follow through √" marks. MR is not applied when the candidate misreads his own figures this is regarded as an error in accuracy. An MR −2 penalty may be applied in particular cases if agreed at the coordination meeting.
- PA –1 This is deducted from A or B marks in the case of premature approximation. The PA –1 penalty is usually discussed at the meeting.

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Obtain quotient $x^2 + 4x + 3$			2	2		
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Obtain answer $a=1$ OR: Substitute a complex zero of x^2-x+1 in $p(x)$ and equate to zero M1 Obtain a correct equation in a in any unsimplified form Expand terms, use $i^2=-1$ and solve for a Obtain answer $a=1$ [SR: The first M1 is earned if inspection reaches an unknown factor x^2+Bx+C and an equation in B and/or C , or an unknown factor Ax^2+Bx+3 and an equation in A and/or B . The second M1 is only earned if use of the equation $a=B-C$ is seen or implied.] (ii) State answer, e.g. $x=-3$ State answer, e.g. $x=-1$ and no others B1 Obtain term $\ln(x+1)$ Obtain term $\ln(x+1)$ Obtain term $\ln(x+1)$ Obtain correct term $\frac{1}{2} \ln \sin 2\theta$ Evaluate a constant, or use limits $\theta = \frac{1}{12}\pi$, $x=0$ in a solution containing terms $a \ln(x+1)$ and $b \ln \sin 2\theta$ Obtain solution in any form, e.g. $\ln(x+1) = \frac{1}{2} \ln \sin 2\theta - \frac{1}{2} \ln \frac{1}{2}$ (f.t. on $k=\pm 1, \pm 2$, or $\pm \frac{1}{2}$) A1 $\sqrt{1}$				uivolont		
OR: Substitute a complex zero of $x^2 - x + 1$ in $p(x)$ and equate to zero $\frac{M1}{Obtain}$ a correct equation in a in any unsimplified form $\frac{A1}{Expand}$ terms, use $i^2 = -1$ and solve for a $\frac{M1}{Obtain}$ answer $a = 1$ $\frac{A1}{Expand}$ [SR: The first M1 is earned if inspection reaches an unknown factor $x^2 + Bx + C$ and an equation in B and/or C , or an unknown factor $Ax^2 + Bx + 3$ and an equation in A and/or B . The second M1 is only earned if use of the equation $a = B - C$ is seen or implied.] (ii) State answer, e.g. $x = -3$ $B1$ State answer, e.g. $x = -1$ and no others $B1$ [Obtain term $B1$ ln sin $B1$ 2 $B1$ Cobtain term $B1$ ln sin $B1$ 2 $B1$ Cobtain correct term $B1$ ln sin $B1$ 2 $B1$ Cobtain correct term $B1$ ln sin $B1$ Evaluate a constant, or use limits $B1$ and $B1$ Evaluate a constant, or use limits $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ ln sin $B1$ Cobtain solution in any form, e.g. $B1$ Substitute in any solution since $B1$ Substitute in any sol				iivaiciit		
Obtain a correct equation in a in any unsimplified form Expand terms, use $i^2 = -1$ and solve for a Obtain answer $a = 1$ [SR: The first M1 is earned if inspection reaches an unknown factor $x^2 + Bx + C$ and an equation in B and/or C , or an unknown factor $Ax^2 + Bx + 3$ and an equation in A and/or A . The second M1 is only earned if use of the equation $A = B - C$ is seen or implied.] (ii) State answer, e.g. $A = -3$ State answer, e.g. $A = -1$ and no others B1 Separate variables and attempt integration of at least one side Obtain term $A = A$ Obtain term $A = A$ Obtain correct term $A = A$ Evaluate a constant, or use limits $A = A$ Evaluate a constant, or use limits $A = A$ Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M2 M3 M4 Obtain solution in any form, e.g. $A = A$ M4 Obtain solution in any form, e.g. $A = A$ M5 M6 Obtain solution in any form, e.g. $A = A$ M6 Obtain solution in any form, e.g. $A = A$ Obtain solution in any form, e.g. $A = A$ Obtain solution in any form, e.g. $A = A$ M6 Obtain solution in any form, e.g. $A = A$ M7 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1 Obtain solution in any form, e.g. $A = A$ M1		OR:		o zero		
Expand terms, use $i^2 = -1$ and solve for a		0111		0 2410		
[SR: The first M1 is earned if inspection reaches an unknown factor x² + Bx + C and an equation in <i>B</i> and/or <i>C</i> , or an unknown factor Ax² + Bx + 3 and an equation in <i>A</i> and/or <i>B</i> . The second M1 is only earned if use of the equation a = B - C is seen or implied.] (ii) State answer, e.g. x = -3 State answer, e.g. x = -1 and no others B1 Separate variables and attempt integration of at least one side Obtain term ln(x + 1) Obtain term k ln sin 2θ, where k = ±1, ±2, or ±½ Obtain correct term ½ ln sin 2θ Evaluate a constant, or use limits θ = ½π, x = 0 in a solution containing terms a ln(x + 1) and b ln sin 2θ Obtain solution in any form, e.g. ln(x + 1) = ½ ln sin 2θ - ½ ln ½ (f.t. on k = ±1, ±2, or ±½) M1 Obtain solution in any form, e.g. ln(x + 1) = ½ ln sin 2θ - ½ ln ½ (f.t. on k = ±1, ±2, or ±½)					M1	
equation in <i>B</i> and/or <i>C</i> , or an unknown factor $Ax^2 + Bx + 3$ and an equation in <i>A</i> and/or <i>B</i> . The second M1 is only earned if use of the equation $a = B - C$ is seen or implied.] (ii) State answer, e.g. $x = -3$ State answer, e.g. $x = -1$ and no others B1 State answer, e.g. $x = -1$ and no others M1 Obtain term $\ln(x + 1)$ Obtain term $\ln(x + 1)$ Obtain term $\ln(x + 1)$ Obtain correct term $\frac{1}{2} \ln \sin 2\theta$ Evaluate a constant, or use limits $\theta = \frac{1}{12}\pi$, $x = 0$ in a solution containing terms $a \ln(x + 1)$ and $a \ln \sin 2\theta$ Obtain solution in any form, e.g. $\ln(x + 1) = \frac{1}{2} \ln \sin 2\theta - \frac{1}{2} \ln \frac{1}{2}$ (f.t. on $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$) M1 Obtain solution in any form, e.g. $\ln(x + 1) = \frac{1}{2} \ln \sin 2\theta - \frac{1}{2} \ln \frac{1}{2}$ (f.t. on $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$)				2	A 1	[4]
State answer, e.g. $x = -1$ and no others B1 [Separate variables and attempt integration of at least one side Obtain term $\ln(x+1)$ Obtain term $k \ln \sin 2\theta$, where $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$ Obtain correct term $\frac{1}{2} \ln \sin 2\theta$ Evaluate a constant, or use limits $\theta = \frac{1}{12}\pi$, $x = 0$ in a solution containing terms $a \ln(x+1)$ and $b \ln \sin 2\theta$ Obtain solution in any form, e.g. $\ln(x+1) = \frac{1}{2} \ln \sin 2\theta - \frac{1}{2} \ln \frac{1}{2}$ (f.t. on $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$) A1 $\sqrt{1}$		equation	on in B and/or C, or an unknown factor $Ax^2 + Bx + 3$ and an equ	uation in A and/or B .		
State answer, e.g. $x = -1$ and no others B1 [Separate variables and attempt integration of at least one side Obtain term $\ln(x+1)$ Obtain term $k \ln \sin 2\theta$, where $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$ Obtain correct term $\frac{1}{2} \ln \sin 2\theta$ Evaluate a constant, or use limits $\theta = \frac{1}{12}\pi$, $x = 0$ in a solution containing terms $a \ln(x+1)$ and $b \ln \sin 2\theta$ Obtain solution in any form, e.g. $\ln(x+1) = \frac{1}{2} \ln \sin 2\theta - \frac{1}{2} \ln \frac{1}{2}$ (f.t. on $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$) A1 $\sqrt{\frac{1}{2}}$		(ii) State a	nswer, e.g. $x = -3$		B1	
Obtain term $\ln(x+1)$ A1 Obtain term $k \ln \sin 2\theta$, where $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$ M1 Obtain correct term $\frac{1}{2} \ln \sin 2\theta$ A1 Evaluate a constant, or use limits $\theta = \frac{1}{12}\pi$, $x = 0$ in a solution containing terms $a \ln(x+1)$ and $b \ln \sin 2\theta$ M1 Obtain solution in any form, e.g. $\ln(x+1) = \frac{1}{2} \ln \sin 2\theta - \frac{1}{2} \ln \frac{1}{2}$ (f.t. on $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$) A1 $\sqrt{\frac{1}{2}}$						[2]
Obtain term $\ln(x+1)$ A1 Obtain term $k \ln \sin 2\theta$, where $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$ M1 Obtain correct term $\frac{1}{2} \ln \sin 2\theta$ A1 Evaluate a constant, or use limits $\theta = \frac{1}{12}\pi$, $x = 0$ in a solution containing terms $a \ln(x+1)$ and $b \ln \sin 2\theta$ M1 Obtain solution in any form, e.g. $\ln(x+1) = \frac{1}{2} \ln \sin 2\theta - \frac{1}{2} \ln \frac{1}{2}$ (f.t. on $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$) A1 $\sqrt{\frac{1}{2}}$	4	Separate va	riables and attempt integration of at least one side		M1	
Obtain correct term $\frac{1}{2} \ln \sin 2\theta$ A1 Evaluate a constant, or use limits $\theta = \frac{1}{12} \pi$, $x = 0$ in a solution containing terms $a \ln(x+1)$ and $b \ln \sin 2\theta$ M1 Obtain solution in any form, e.g. $\ln(x+1) = \frac{1}{2} \ln \sin 2\theta - \frac{1}{2} \ln \frac{1}{2}$ (f.t. on $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$) A1 $\sqrt{\frac{1}{2}}$		Obtain term	ln(x+1)		A1	
Evaluate a constant, or use limits $\theta = \frac{1}{12}\pi$, $x = 0$ in a solution containing terms $a \ln(x+1)$ and $b \ln \sin 2\theta$ M1 Obtain solution in any form, e.g. $\ln(x+1) = \frac{1}{2} \ln \sin 2\theta - \frac{1}{2} \ln \frac{1}{2}$ (f.t. on $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$) A1 $\sqrt{\frac{1}{2}}$						
b ln sin 2θ M1 Obtain solution in any form, e.g. $\ln(x+1) = \frac{1}{2} \ln \sin 2\theta - \frac{1}{2} \ln \frac{1}{2}$ (f.t. on $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$) A1 $\sqrt{\frac{1}{2}}$			2	erms $a \ln(r+1)$ and	Al	
Obtain solution in any form, e.g. $\ln(x+1) = \frac{1}{2} \ln \sin 2\theta - \frac{1}{2} \ln \frac{1}{2}$ (f.t. on $k = \pm 1, \pm 2$, or $\pm \frac{1}{2}$) A1 $\sqrt{\frac{1}{2}}$			constant, or use minus $v = \frac{1}{12}n$, $x = 0$ in a solution containing v	orms a m(x ± 1) and	M1	
			tion in any form, e.g. $\ln(x+1) = \frac{1}{2} \ln \sin 2\theta - \frac{1}{2} \ln \frac{1}{2}$ (f.t. on $k = \frac{1}{2} \ln \frac{1}{2}$)	$\pm 1, \pm 2, \text{ or } \pm \frac{1}{2})$		
			2 2 2	-	A1	[7]

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5	(i)		ognisable sketch of a relevant graph over the given interval e other relevant graph and justify the given statement		B1 B1	[2]
	(ii)	Consider	the sign of sec $x - (3 - \frac{1}{2} x^2)$ at $x = 1$ and $x = 1.4$, or equival	ent	M1	
		Complete	the argument with correct calculated values		A1	[2]
	(iii)	Convert the	the given equation to $\sec x = 3 - \frac{1}{2}x^2$ or work <i>vice versa</i>		B1	[1]
	(iv)	Obtain fir	rect iterative formula correctly at least once nal answer 1.13		M1 A1	
		Show sufficient iterations to 4 d.p. to justify 1.13 to 2 d.p., or show there is a sign change in the interval (1.125, 1.135) [SR: Successive evaluation of the iterative function with $x = 1, 2,$ scores M0.]			A1	[3]
6	(i)	Use trig for Obtain α	imply $R = \sqrt{10}$ formulae to find α = 71.57° with no errors seen llow radians in this part. If the only trig error is a sign error	or in $\cos(x - a)$ give	B1 M1 A1	[3]
	(ii)	Carry out Obtain an Use an ap Obtain set [Ignore ar [Treat ans [SR: The $\cos 2\theta$, or in the given of the cos 2θ , or in the given obtain an $\cos 2\theta$, or $\cos 2\theta$, and $\cos 2\theta$, or $\cos 2\theta$, or $\cos 2\theta$, and $\cos 2\theta$	an appropriate method to find a value of 2θ in $0^{\circ} < 2\theta < 18$ answer for θ in the given range, e.g. $\theta = 61.2^{\circ}$ appropriate method to find another value of 2θ in the above range of angle, e.g. $\theta = 10.4^{\circ}$, and no others in the given range as swers outside the given range.] swers in radians as a misread and deduct A1 from the answer use of correct trig formulae to obtain a 3-term quadrate tan 2θ earns M1; then A1 for a correct quadratic, M1 for one range, and A1 + A1 for the two correct answers (candidate spurious roots to get the final A1).]	onge angles.] the interpolation in tan θ , sin 2θ , btaining a value of θ)	[5]

		l.	00171077111111 00101			<u> </u>		
7	(i)		rect method to express \overrightarrow{OP} in terms given answer	ns of λ		M1 A1	[2]	
((ii)	EITHER:	Use correct method to express so in terms of λ Using the correct method for the moduli and express $\cos AOP = \cos AOP = OOP = O$	e moduli, divide scal	ar products by products	M1 of		
		OR1:	Use correct method to express C of λ Using the correct method for the product of the relevant moduli a or λ and OP	e moduli, divide eac	h expression by twice the	M1		
		01		$9 + 2\lambda$	$11 + 14\lambda$			
		Obtain a c	correct equation in any form, e.g.	$\frac{1}{3\sqrt{(9+4\lambda+12\lambda^2)}} =$	$= \frac{1}{5\sqrt{(9+4\lambda+12\lambda^2)}}$	A1		
		Solve for A	λ	•	M	11(dep*)		
		Obtain $\lambda = \frac{3}{8}$						
		[SR: The M1* can also be earned by equating $\cos AOP$ or $\cos BOP$ to a sound attempt at $\cos \frac{1}{2} AOB$ and obtaining an equation in λ . The exact value of the cosine is $\sqrt{(13/15)}$, but accept non-exact working giving a value of λ which rounds to 0.375, provided the						
		spurious negative root of the quadratic in λ is rejected.] [SR: Allow a solution reaching $\lambda = \frac{3}{8}$ after cancelling identical incorrect expressions for						
		<i>OP</i> to score 4/5. The marking will run M1M1A0M1A1, or M1M1A1M1A0 in sucl cases.]						
	(iii)	Verify the	e given statement correctly			B1	[1]	
8	(i)		elevant method to determine a cor			M1		
			e of the values $A = 3$, $B = 4$, $C = 0$)		A1		
			second value e third value			A1 A1	[4]	
	(ii)	Integrate a	and obtain term $-3 \ln(2-x)$			В1√		
	` '	Integrate a	and obtain term $k \ln(4 + x^2)$			M1		
			$rm 2 ln(4+x^2)$	1040 1040 00-1 -641 - 6		A1√		
			correct limits correctly in a comp $a + b \ln(4 + x^2)$, $ab \neq 0$	olete integral of the fo	orm	M1		
		Obtain air	yon anguar fallowing full and com	root working		Λ1	[5]	

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Paper

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A1

[5]

Page 6

Obtain given answer following full and correct working

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9	(i)	Equate de Obtain an	erivative in any form erivative to zero and solve for x as $e^{-\frac{1}{2}}$, or equivalent		M1 A1 M1 A1	[2]
		Obtain an	swer $y = -\frac{1}{2} e^{-1}$, or equivalent		A1	[5]
	(ii)	Attempt i	ntegration by parts reaching $kx^3 \ln x \pm k \int x^3 \cdot \frac{1}{x} dx$		M1*	
		Obtain $\frac{1}{3}$.	$x^3 \ln x - \frac{1}{3} \int x^2 dx$, or equivalent		A1	
		Integrate	again and obtain $\frac{1}{3}x^3 \ln x - \frac{1}{9}x^3$, or equivalent		A1	
			s x = 1 and $x = e$, having integrated twice		M1(dep*)	
			swer $\frac{1}{9}(2e^3 + 1)$, or exact equivalent		A1	[5]
		[SR: An a	attempt reaching $ax^2 (x \ln x - x) + b \int 2x(x \ln x - x) dx$ score	es M1. Then give	the	
		first A1 fo	or $I = x^2 (x \ln x - x) - 2I + \int 2x^2 dx$, or equivalent.]			
10	(a)	EITHER:	Square $x + iy$ and equate real and imaginary parts to 1 and	$1 - 2\sqrt{6}$ respective	ely M1*	
			Obtain $x^2 - y^2 = 1$ and $2xy = -2\sqrt{6}$		A1	
			Eliminate one variable and find an equation in the other Obtain $x^4 - x^2 - 6 = 0$ or $y^4 + y^2 - 6 = 0$, or 3-term equivalent		M1(dep*) A1	
			Obtain answers $\pm (\sqrt{3} - i\sqrt{2})$		A1	[5]
		OR:	Denoting $1 - 2\sqrt{6i}$ by $R \operatorname{cis} \theta$, state, or imply, square ro	ots are $\pm \sqrt{R} \operatorname{cis}(\frac{1}{2})$	(θ)	
			and find values of R and either $\cos \theta$ or $\sin \theta$ or $\tan \theta$	_	M1*	
			Obtain $\pm \sqrt{5} \left(\cos \frac{1}{2} \theta + i \sin \frac{1}{2} \theta\right)$, and $\cos \theta = \frac{1}{5}$ or	$\sin\theta = -\frac{2\sqrt{6}}{5}$	or	
			$\tan\theta = -2\sqrt{6}$		A1	
			Use correct method to find an exact value of $\cos \frac{1}{2}\theta$ or si	$\ln \frac{1}{2}\theta$	M1(dep*)	
			Obtain $\cos \frac{1}{2}\theta = \pm \sqrt{\frac{3}{5}}$ and $\sin \frac{1}{2}\theta = \pm \sqrt{\frac{2}{5}}$, or equivalent		A1	
			Obtain answers $\pm (\sqrt{3} - i\sqrt{2})$, or equivalent		A1	
			[Condone omission of \pm except in the final answers.]			
	(b)	Charren = :	nt representing 2i on a gleatab of an Argand diagram		D1	
	(n)		nt representing 3i on a sketch of an Argand diagram ircle with centre at the point representing 3i and radius 2		B1 B1√	
		Shade the	interior of the circle		В1√	
		-	a complete method for finding the greatest value of arg z swer 131.8° or 2.30 (or 2.3) radians		M1 A1	[5]
			s on solutions where the centre is at the point representing –	2; 1	7.1.1	٢٠]

[The f.t. is on solutions where the centre is at the point representing –3i.]