MARK SCHEME for the May/June 2011 question paper

for the guidance of teachers

0606 ADDITIONAL MATHEMATICS

0606/12

Paper 1, maximum raw mark 80

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.

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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 Accuracy 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.

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

- 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)
- 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)

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 $\sqrt{}$ " marks. MR is not applied when the candidate misreads his own figures this is regarded as an error in accuracy.
- OW –1,2 This is deducted from A or B marks when essential working is omitted.
- PA –1 This is deducted from A or B marks in the case of premature approximation.
- S –1 Occasionally used for persistent slackness usually discussed at a meeting.
- EX –1 Applied to A or B marks when extra solutions are offered to a particular equation. Again, this is usually discussed at the meeting.

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$ \begin{array}{c} (2k+10)^2 = 4\left(k^2+5\right) & \text{MI} & \text{MI for solution} \\ k=-2 & \text{II} \\ (\text{or } \frac{dy}{dx} = 2x + (2k+10), x = -(k+5) & \text{MI} \\ (\text{ading to } k=-2) & \text{MI} & \text{MI for differentiation and attempt to} \\ equate to zero. & \text{MI for attempt to substitute in for x in the solution} \\ (\text{or } (x+4)^2 = x^2 + (2k+10)x + k^2 + 5 & \text{MI} & \text{MI for attempt to substitute in for x in the solution} \\ (\text{or } (x+4)^2 = x^2 + (2k+10)x + k^2 + 5 & \text{MI} & \text{MI for attempt at solution} \\ (k+5)^2 = k^2 + 5, \text{leading to } k = -2) & \text{AI} & \text{MI for approach} \\ (k+5)^2 = k^2 + 5, \text{leading to } k = -2) & \text{AI} & \text{MI for approach} \\ (k+5)^2 = k^2 + 5, \text{leading to } k = -2) & \text{AI} & \text{MI for approach} \\ (k+5)^2 = k^2 + 5, \text{leading to } k = -2) & \text{AI} & \text{MI for approach} \\ (k+5)^2 = k^2 + 5, \text{leading to } k = -2) & \text{AI} & \text{MI for approach} \\ (k+5)^2 = k^2 + 5 & \text{MI} & \text{MI for approach} \\ a = \frac{1}{6} & \text{MI} & \text{MI for approach} & \text{MI for attempt to solve} \\ \end{array}$ $\begin{array}{c} 2 {}^{3}C_{3}2^{2}a^{3} = (10)^{4}C_{2}\frac{a^{2}}{9} & \text{BIBI} \\ a = \frac{1}{6} & \text{MI} & \text{MI for arclationship between the 2 coefficients and attempt to solve} \\ \hline \end{array}$ $\begin{array}{c} \text{MI for actempt to rationalise and attempt to solve & \text{AI} & \text{AI} \\ \text{MI for attempt to rationalise and attempt to solve & \text{AI} \\ \hline \end{array}$ $\begin{array}{c} \text{MI for attempt to rationalise and attempt to expand \\ \hline \end{array}$ $\begin{array}{c} \text{MI for attempt to rationalise and attempt to expand \\ \text{MI for attempt to expand \\ \hline \end{array}$	1	$x^2 + (2k + 10)$	$x + \left(k^2 + 5\right) = 0$	M1		se of	
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$\begin{array}{c} \text{A1} \\ \text{[4]} \end{array}$ $\begin{array}{c} \text{Control its and attempt to solve} \\ \text{A1} \\ \text{[4]} \end{array}$ $\begin{array}{c} \text{B1} \\ \text{B1} \\ \text{B1} \\ \text{B1} \\ \text{[5]} \end{array}$ $\begin{array}{c} \text{B1} \\ \text{B1} \\ \text{B1} \\ \text{B1} \\ \text{[5]} \end{array}$ $\begin{array}{c} \text{B1} \\ \text{B1} \\ \text{B1} \\ \text{B1} \\ \text{[5]} \end{array}$ $\begin{array}{c} \text{A1} \\ \text{(i)} \frac{(4+\sqrt{2})}{(1+\sqrt{2})} \frac{(1-\sqrt{2})}{(1-\sqrt{2})} = 2\sqrt{2} \\ \text{(ii)} \text{Area} = \frac{1}{2} \times (4+2\sqrt{2}) \times (1+\sqrt{2}) \\ = 4+3\sqrt{2} \\ \text{(iii)} \text{Area} = AC^{2} \\ = (4+2\sqrt{2})^{2} + (1+\sqrt{2})^{2} \\ = 27+18\sqrt{2} \end{array}$ $\begin{array}{c} \text{M1} \\ \text{M1} \text{for attempt at area using surd form and attempt to expand \\ \text{M1} \text{for attempt to expand } \\ \end{array}$	2	${}^{5}C_{3}2^{2}a^{3} = (10)$	$())^{4}C_{2}\frac{a^{2}}{9}$	B1B1	B1 for ${}^{5}C_{3}2^{2}a^{3}$, B1 for ${}^{4}C_{2}\frac{a}{c}$	$\frac{q^2}{2}$	
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$=27+18\sqrt{2}$ A1 form, with attempt to expand		(iii) Area = A	C^2				
$=27+18\sqrt{2}$ A1 form, with attempt to expand		$=(4+2\sqrt{2})$	$\sqrt{2}^{2} + (1 + \sqrt{2})^{2}$	M1	M1 for attempt at AC^2 or AC	in surd	
[0]		× ×	/ (/	A1 [6]	form, with attempt to expand		

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5 (i) 2	$2\left(\frac{1}{8}\right) - 5\left(\frac{1}{4}\right) + 10\left(\frac{1}{2}\right) - 4$	M1	M1 for substitution of $x = 0.5$ or attempt at long division		
=	0	A1			
(ii) $(2x-1)(x^2-2x+4)$			M1 attempt to obtain quadratic factor		
For $(x^2 - 2)$	$2x+4$), ' $b^2 < 4ac$ '	M1	A1 for correct quadratic factor M1 for correct use of discriminant or solution of quadratic equation $= 0$		
so only one	e real root of $x = 0.5$	A1 [6]	A1, all correct with statement of root.		
6 (i) lg	$gy-3=\frac{1}{5}(x-5)$	B1M1 A1	B1 for gradient, M1 for use of straight line equation		
	Either $b = \frac{1}{5}$	B1	B1 for $b = \frac{1}{5}$		
	$v = 10^{\left(\frac{1}{5}x+2\right)},$ = $10^{\frac{1}{5}x}10^{2}$	M1	M1 for use of powers of 10 correctly to obtain a		
	$a = 10^{5} 10^{2}$ a = 100	A1 [6]	A1 for <i>a</i>		
	$ lg y = lg a + lg 10^{bx} g y = lg a + bx, lg a = 2 $	M1	M1 for use of logarithms correctly to obtain <i>a</i>		
а	<i>u</i> = 100	A1	A1 for <i>a</i>		
b	$p = \frac{1}{5}$	B1	B1 for $b = \frac{1}{5}$		
	Or $10^3 = a(10)^{5b}$ $0^5 = a(10)^{15b}$	M1	M1 for simultaneous equations involving powers of 10		
b	$p = \frac{1}{5}, a = 100$	B1, A1	B1 for $b = \frac{1}{5}$, A1 for $a = 100$		
7 (i) ¹⁴	${}^{4}C_{6} = 3003$	B1			
(ii) ⁸ ($C_4 \times {}^6C_2$	B1B1	B1 for ${}^{8}C_{4}$ or ${}^{6}C_{2}$		
=	= 1050	B1	B1 for × by ${}^{6}C_{2}$ or ${}^{8}C_{4}$		
			B1 for 1050		
(iii) ⁸ ($C_6 + 6^8 C_5 = 364$	B1B1	B1 for ${}^{8}C_{6}$ or equivalent		
		B1	B1 for $6^{8}C_{5}$ or equivalent		
		[7]	B1 for 364		

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8	(i)	I				
			B1 B1	B1 for $x = -0.5$ B1 for $x = 2.5$ B1 for $y = -5$ B1 for shape		
	(ii)	(1,-9)	B1			
	(iii)			√B1 on shape from (i) B1 for a completely correct sketch		
9	(i)	$\Delta OBA: \theta + 2\left(\frac{\theta}{3}\right) = \pi$		M1 for using angles in an isosceles triangle		
	(ii)	$9\pi = r \times \frac{3\pi}{5}$ r = 15	M1 A1	M1 for use of $s = r\theta$		
	(iii)	Area = $\left(\frac{1}{2} \times 15^2 \times \frac{3\pi}{5}\right) - \left(\frac{1}{2} \times 15^2 \times s\right)$ =105	A1 [7]	M1 for use of $\frac{1}{2}r^2\theta$ or $\frac{1}{2}rs$ M1 for use of $\frac{1}{2}r^2\sin\theta$ or other correct method		
10	(i)	$ \begin{pmatrix} 29 \\ -13 \end{pmatrix} - \begin{pmatrix} 5 \\ -6 \end{pmatrix} = \begin{pmatrix} 24 \\ -7 \end{pmatrix} $	M1	M1 for subtraction		
		Magnitude = 25, unit vector $\frac{1}{25} \begin{pmatrix} 24 \\ -7 \end{pmatrix}$	M1 A1	M1 for attempt to find magnitude of their vector		
	(ii)	$2\overrightarrow{AC} = 3\overrightarrow{AB}$ or $2\overrightarrow{AB} + 2\overrightarrow{BC} = 3\overrightarrow{AB}$ leading to $\overrightarrow{AC} = \begin{pmatrix} 36\\ -10.5 \end{pmatrix}$		M1 for attempt to find \overrightarrow{AC} – may be part of a larger method		
		$\overrightarrow{OC} = \overrightarrow{OA} + \overrightarrow{AC}$ or $\overrightarrow{OB} - \overrightarrow{OA} = 2\overrightarrow{OC} - 2\overrightarrow{OB}$	M1	M1 for attempt to find \overrightarrow{OC}		
		leading to $\overrightarrow{OC} = \begin{pmatrix} 41\\ -16.5 \end{pmatrix}$	A1	A1 for each		
		(equivalent methods acceptable)	[7]			

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11	(i)	$2\cos ec^2$	$x - 5\cos ecx - 3 = 0$	M1A1	M1 for u to get in	tity or attempt		
		`	$\theta + 1)(\cos \operatorname{ec} \theta - 3) = 0$	DM1	DM1 for attempt to solve			
		leading to	$\sin x = \frac{1}{3}, x = 19.5^{\circ}, 160.5^{\circ}$	A1√A1	√ 180°-	their x		
	(ii)	$\tan 2y =$	$\frac{5}{4}$	M1	M1 for a	M1 for attempt to get in terms of tan		
		2 <i>y</i> = 51.3	4°, 231.34°	M1	M1 for d angle	ealing correctly w	vith double	
		$y = 25.7^{\circ}$, 115.7°	A1,√A1	$\sqrt{90^\circ}$ the	ir y		
	(iii)		$=\frac{2\pi}{3},\frac{4\pi}{3}$ $\frac{\pi}{6}\qquad \left(\frac{4\pi}{3}-\frac{\pi}{6}\right)$	M1	M1 for dealing with order correctly and attempt to solve			
		$z=\frac{\pi}{2},\frac{7}{6}$	$\frac{\pi}{5}$ allow 1.57, 3.67	A1, A1 [12]				
12	EIT	HER						
	(i)	$\frac{\mathrm{d}y}{\mathrm{d}x} = 9x^2$		M1	M1 for d $x = -1$	ifferentiation and	substitution of	
		when x =	$-1, \frac{\mathrm{d}y}{\mathrm{d}x} = 0$					
		tangent y A (0, 5)	eet	DM1 A1		attempt at equation dinates of A	on of tangent	
	(ii)	<i>B</i> (0, 1)		B1	B1 for <i>B</i>			
		At <i>B</i> , $\frac{\mathrm{d}y}{\mathrm{d}x}$						
			$x-1 = \frac{1}{5}x$ C (-5, 0)	M1A1		ttempt at normal a rentiation and us		
		At $D \frac{1}{5}x$	+1=5, D (20, 5)	M1A1		ttempt to obtain <i>L</i> nd tangent equation		
		Area = $\frac{1}{2}$	$\times 20 \times 5$,	M1	M1 for v	alid attempt at are	ea	
		= 50		A1 [10]				

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12	OR $\frac{dy}{dx} = 3x^2 - 12$ When $\frac{dy}{dx} = 0$, Area = $8 - \int_{1}^{3}$ $= 8 - \left[\frac{x^4}{4} - 2\right]$	IGCSE - May/June $F(x+9)$ $F(1,4)$		M1 for d can be us M1 for a A1 for b A1 for y $\sqrt{B1}$ on y	0606 Sifferentiation and sing a product ttempt to solve oth x values coordinate y coordinate for ar ttempt to integrate	12 equating to 0, ea of rectangle
	$=8-\frac{27}{4}+\frac{11}{4}$		DM1	DM1 for	application of lin	nits
	= 4		A1 [10]			