UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Ordinary Level

MARK SCHEME for the May/June 2012 question paper

for the guidance of teachers

4037 ADDITIONAL MATHEMATICS

4037/22 Paper 2, 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.

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 √" 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.

1	**(i)** $7 \in P$	B1
	(ii) $8 \notin S$	B1
	(iii) $\mathrm{n}(N \cap S) = 6$	B1
2	**(i)** $k\sqrt{4x+1}$ oe $k = 6$ allow unsimplified	M1 A1
	(ii) Use $\partial y = \dfrac{dy}{dx}_{(x=6)} \times p$	M1
	$30p$	A1√
3	Eliminate y $x^2 + (3-m)x + 9 = 0$ Use $m = -3$ or $9b^2 - 4ac \approx 0$ Solve for 2 values of m Solve for 2 values of m OR Eliminate y and m $((2x+3)x - 5 = x^2 + 3x + 4)$ Solve quadratic for x Solve for 2 values of m	M1 A1 M1 M1 A1
4	**(i)** $\begin{pmatrix}4&1&7\\2&5&1\end{pmatrix}\begin{pmatrix}5\\3\\1\end{pmatrix}$ or transpose	B1
	$+\begin{pmatrix}2&5&2\\4&3&6\end{pmatrix}\begin{pmatrix}8\\4\\2\end{pmatrix}$ or transpose	B1+B1
	(ii) $\begin{pmatrix}30\\26\end{pmatrix}$ or $\begin{pmatrix}40\\56\end{pmatrix}$ or $\begin{pmatrix}30\\y\end{pmatrix}$ and $\begin{pmatrix}40\\y\end{pmatrix}$ or $\begin{pmatrix}x\\26\end{pmatrix}$ and $\begin{pmatrix}x\\56\end{pmatrix}$ from correct part **(i)**	B1
	Claire 70 and Denise 82	B1
5	**(i)** $f(2)(=8+4k-16-8) = 0$ $k = 4$	M1 A1
	(ii) Find quadratic factor $x^2 + 6x + 4$ Use quadratic formula or completing square $\dfrac{-6 \pm \sqrt{6^2 - 4\times(1)\times 4}}{2}$ $-3 \pm \sqrt{5}$	M1 A1 M1 A1 B1√

6	**(a) (i)** $(-2)^3$ or 35	B1
	-280	B1
	(ii) $2^2 \times 21(x^2)$	B1
	$3\times(-280)+4\times(84)$	M1
	-504	A1
	(b) Identify $x^4 \times \left(\frac{3}{x^2}\right)^2$	B1
	$\times 15$ only with x^0	B1
	$135(x^0)$	B1
7	**(i)** $\ln y = \ln a + b\ln x$ OR $\lg y = \lg a + b\lg x$ may be implied	B1
	Plot $\ln y$ / $\lg y$ against $\ln x$ / $\lg x$ with attempt at linear scale	M1
	$\ln x$ 1.61 3.40 5.01 5.99 $\ln y$ 2.19 3.09 3.89 4.39	A2, 1, 0
	$\lg x$ 0.70 1.48 2.18 2.60 $\lg y$ 0.95 1.34 1.69 1.91	
	(Marks for points and line on graph **NOT** for table)	
	(ii) Calculates gradient of straight line log graph	M1
	$b = 0.5 \pm 0.03$	A1
	Intercept is ln a or lg a on straight line log graph	M1
	$a = 4 \pm 0.3$	A1
	(iii) Uses suitable graph or formula	M1
	32 to 49	A1

8	$x^2h = 256$	OR	B1
	$A = x^2 + 4xh$		M1
	$A = x^2 + \frac{1024}{x}$	$A = \frac{256}{h} + 64\sqrt{h}$	A1
	$\frac{dA}{dx} = 2x - \frac{1024}{x^2}$ oe	$\frac{dA}{dh} = \frac{-256}{h^2} + \frac{32}{\sqrt{h}}$	A1√
	Equate to 0 and solve	$h = 4$	M1
	$x = 8$	$x = 8$	A1
	$h = 4$		A1

9	**(a)** **(i)**	$\tan x = \frac{5}{3}$	B1
		$x = 59(.0)$	B1
		$x = 239(.0)$ and no others	B1√
	(ii)	Use $\sin^2 y = 1 - \cos^2 y$	B1
		$5\cos^2 y - 9\cos y - 2 = 0$	B1
		Solve 3 term quadratic (in cos$y$)	M1
		101.5	A1
		258.5 and no others	B1√
	(b)	$(3 - z) = 0.927$ or 0.93	B1
		2.07	B1
		$(3 - z) = \pi - 0.927$	M1
		0.786 or 0.785 or 0.79 and no others	A1
10	**(a)** **(i)**	792	B1
	(ii)	4W, 3M and 5W, 2M	M1
		5×35 or $(1) \times 21$	B1
		196	A1
	(b) **(i)**	$4 \times 5 \times 4 \times 3$ or $\frac{2}{3} \times 6 \times 5 \times 4 \times 3$	M1
		240	A1
	(ii)	$4 \times 4 \times 3 \times 1$ or $\frac{1}{5} \times (240)$	M1
		48	A1

11	E	**(i)** $\frac{dy}{dx} = k\cos\frac{1}{2}x \quad \left(\frac{1}{2}\cos\frac{1}{2}x\right)$	M1
		Gradient tangent $-\frac{1}{4}\sqrt{2}$ or –0.35…	A1
		$y - \frac{\sqrt{2}}{2} = -\frac{1}{4}\sqrt{2}\left(x - \frac{3\pi}{2}\right)$	M1
		$y = 0, x = \frac{3\pi}{2} + 2$ or 6.71	A1
		(ii) METHOD A	
		$\int \sin\frac{1}{2}x\,dx = -2\cos\frac{1}{2}x$	B1
		Identify 2π	B1
		Use limits of 1.5π and (2π) on $k\cos\frac{1}{2}x \quad \left(2 - \sqrt{2} \text{ or } 0.586\right)$	M1
		Attempt at area of triangle $\left(= \frac{\sqrt{2}}{2} = 0.707\right)$	M1
		Idea of area of triangle subtract area under curve.	M1
		Plan completely correct	M1
		$\frac{3\sqrt{2}}{2} - 2$ or 0.121	A1
		METHOD B	
		Using integral of (equation of line $-$ equation of curve)	M1
		$\int \sin\frac{1}{2}x\,dx = -2\cos\frac{1}{2}x$	B1
		Identify 2π	B1
		Use limits of 1.5π and (2π) on $k\cos\frac{1}{2}x$	M1
		Use limits of 1.5π and (x_Q) on integral of equation of line	M1
		Plan completely correct	M1
		$\frac{3\sqrt{2}}{2} - 2$ or 0.121	A1

11	**O**	**(i)** Uses product rule	M1
		$(1-x)\mathrm{e}^{-x}$	A1
		$\int(1-x)\mathrm{e}^{-x}\mathrm{d}x = x\mathrm{e}^{-x}$	M1
		$\int x\mathrm{e}^{-x}\mathrm{d}x = -x\mathrm{e}^{-x} + \int \mathrm{e}^{-x}\mathrm{d}x \; = = -x\mathrm{e}^{-x} - \mathrm{e}^{-x}$	A1ag
		(ii) gradient tangent $= -\frac{1}{\mathrm{e}^2}$ or $= -0.135$	B1
		$y - \frac{2}{\mathrm{e}^2} = -\frac{1}{\mathrm{e}^2}(x-2)$	M1
		Uses line cuts y-axis at $\frac{4}{\mathrm{e}^2}$ or 0.541	A1
		Area trapezium $\left(= \frac{6}{\mathrm{e}^2} \text{ or } 0.812 \right)$	M1
		Uses limits of 2 and 0 on $-x\mathrm{e}^{-x} - \mathrm{e}^{-x}$ $(=1-\frac{3}{\mathrm{e}^2}$ or 0.594)	M1
		Evaluate area of trapezium subtract area under curve	M1
		$\frac{9}{\mathrm{e}^2} - 1$ or 0.218	A1