OCR
Oxford Cambridge and RSA

GCE

Mathematics (MEI)

Unit **4751**: Introduction to Advanced Mathematics (C1)

Advanced Subsidiary GCE

Mark Scheme for June 2015

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Annotations and abbreviations

Annotation in scoris	**Meaning**
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	
Other abbreviations in mark scheme	**Meaning**
E1	Mark for explaining
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working

Subject-specific Marking Instructions for GCE Mathematics (MEI) Pure strand

a Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

c The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually 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, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

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). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E
A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

g Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

h For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

Question			Answer	Marks	Guidance	
1			$[r =]\sqrt{\frac{A}{\pi(x+y)}}$ or $[r =]\sqrt{\frac{A}{\pi x+\pi y}}$ as final answer	2 **[2]**	square root symbol must extend below fraction line; accept to power ½ with appropriate brackets **M1** for a triple decker fraction or for $r^2 = \frac{A}{\pi(x+y)}$ or for $[r =]\pm\sqrt{\frac{A}{\pi(x+y)}}$ or for their final answer for r ft their r^2	condone missing end bracket in denominator eg M1 for $[r =]\sqrt{\frac{A}{\frac{\pi}{(x+y)}}}$
2			$y = 4x + 10$ (0, 10) or ft (–10/4, 0) oe or ft	B3 B1 B1 **[5]**	**M1** for $y = 4x + b$ oe and **M1** for $y – 6 =$ their a $(x + 1)$ oe or for (–1, 6) subst in $y =$ (their a)$x + b$ oe or **M1** for $y = ax + 10$ condone $y = 10$ isw condone $x = –10/4$ isw	condone lack of brackets and eg $y = 10$, $x = –2.5$ or ft isw but B0, SC1 for poor notation such as (–2.5, 10) with no better answers seen Throughout the scheme, note that for evaluated rational answers, unless specified otherwise, fractional or decimal equivalents are acceptable, but not triple-decker fractions etc; integer answers must be simplified to an integer

Question			Answer	Marks	Guidance	Question
3	(i)		1	1 **[1]**		
3	(ii)		$\frac{3}{5}$ or 0.6	3 **[3]**	allow **B3** for ±0.6 oe; **M1** for $\left(\frac{25}{9}\right)^{-\frac{1}{2}} = \left(\frac{9}{25}\right)^{\frac{1}{2}}$ soi or $\frac{1}{\left(\frac{25}{9}\right)^{\frac{1}{2}}}$ and **M1** for at least one of 3 and 5 found	M1 for inversion even if they have done something else first, eg may be earned after 2nd M1 for inversion of their $\frac{5}{3}$
4			$4x - 5 > 14x + 7$ $-12 > 10x$ or $-10x > 12$ or ft $x < -\frac{12}{10}$ or $-\frac{12}{10} > x$ oe isw or ft	M1 M1 M1 **[3]**	for correctly multiplying by 7 to eliminate the fraction, including expanding bracket if this step done first for correctly collecting x terms on one side and number terms on the other and simplifying ft their ax [inequality] b, where $b \neq 0$ and $a \neq 0$ or ±1	may be earned later; the first two Ms may be earned with an equation or wrong inequality ft wrong first step award 3 marks only if correct answer obtained after equations or inequalities are used with no errors
5			$x + 3(5x - 2) = 8$ or $y = 5(8 - 3y) - 2$ $16x = 14$ or $16y = 38$ (7/8, 19/8) oe	M1 M1 A2 **[4]**	for subst to eliminate one variable; condone one error; for collecting terms and simplifying; condoning one error ft or $x = 14/16$, $y = 38/16$ oe isw allow **A1** for each coordinate	or multn or divn of one or both eqns to get a pair of coeffts the same, condoning one error appropriate addn or subtn to eliminate a variable, condoning an error in one term; if subtracting, condone eg y instead of 0 if no other errors

Question			Answer	Marks	Guidance	Question
6	(i)		$-31 + 6\sqrt{5}$	3 **[3]**	**B2** for –31 or **B1** for 9 – 40 or **SC1** for 49 and **B1** for $6\sqrt{5}$ if 0, allow **M1** for three terms correct in $9-6\sqrt{5}+12\sqrt{5}-40$	
6	(ii)		$22\sqrt{2}$	2 **[2]**	**M1** for $\sqrt{72}=6\sqrt{2}$ soi or for $\frac{32}{\sqrt{2}}=16\sqrt{2}$ soi or for $\frac{12+32}{\sqrt{2}}$ oe	
7			$81x^4 - 216x^3 + 216x^2 - 96x + 16$	4 **[4]**	**M3** for 4 terms correct or for all coefficients correct except for sign errors or for correct answer seen then further 'simplified' or for all terms correct eg seen in table but not combined or **M2** for 3 terms correct or for correct expansion seen without correct evaluation of coefficients [if brackets missing in elements such as $(3x)^2$ there must be evidence from calculation that $9x^2$ has been used] or **M1** for 1 4 6 4 1 row of Pascal's triangle seen	condone eg +(–96x) or +–96x instead of –96x any who multiply out instead of using binomial coeffts: look at their final answer and mark as per main scheme if 3 or more terms are correct, otherwise M0 binomial coefficients such as ${}^4C_2$ or $\binom{4}{2}$ are not sufficient – must show understanding of these symbols by at least partial evaluation;

Question			Answer	Marks	Guidance	Question
8	(i)		$(3x)^2 = h^2 + (2x + 1)^2$ oe	B1	for a correct Pythagoras statement for this triangle, in terms of x, with correct brackets	condone another letter instead of h for one mark but not both unless recovered at some point
			$9x^2 = h^2 + 4x^2 + 4x + 1$ and completion to given answer , $h^2 = 5x^2 - 4x - 1$	B1 **[2]**	for correct expansion, with brackets or correct signs; must complete to the given answer with no errors in any interim working may follow $3x^2 = h^2 + (2x + 1)^2$ oe for **B0 B1**	eg B1 for $h^2 = 9x^2 - (4x^2 + 4x + 1)$ and completion to correct answer but B0 for $h^2 = 9x^2 - 4x^2 + 4x + 1$
8	(ii)		$[0 =] 5x^2 - 4x - 8$	B1	for subst and correctly rearranging to zero	
			$\frac{4 \pm \sqrt{(-4)^2 - 4 \times 5 \times -8}}{2 \times 5}$ or ft	M1	for use of formula in their eqn rearranged to zero, condoning one error; ft only if their rearranged eqn is a 3-term quadratic; no ft from $5x^2 - 4x - 1$ [=0]	or M1 for $\left(x - \frac{2}{5}\right)^2 = \left(\frac{2}{5}\right)^2 + \frac{8}{5}$ oe, (condoning one error), which also implies first M1 if not previously earned M0 for factorising ft
			$\frac{4 + \sqrt{176}}{10}$ or $\frac{2}{5} + \frac{\sqrt{44}}{5}$ oe	A1 **[3]**	isw wrong simplification; **A0** if negative root also included	
9	(i)		the diagonals of a rhombus also intersect at 90°	B1	oe for kite or other valid statement/sketch **B0** if eg rectangle or parallelogram etc also included as having diagonals intersecting at 90°	accept 'diamond' etc reference merely to 'other shapes' having diagonals intersecting at 90° is not sufficient; sketches must have diagonals drawn, intersecting approx. at right angles but need not be ruled
			ABCD is a square ⇒ the diagonals of quadrilateral ABCD intersect at 90°	B1 **[2]**	oe; **B0** if no attempt at explanation (explanation does not need to gain a mark)	Do not accept → oe

Question			Answer	Marks	Guidance	Question
9	(ii)		eg 8 is an integer but $\sqrt{8}$ is not an integer	B1	oe with another valid number, or equivalent explanation **B1** for the square root of some integers is a surd / irrational number / decimal	0 for 'the square root of some integers is a fraction'
			x^2 is an integer $\Leftarrow$ x is an integer	B1 **[2]**	**B0** if no attempt at explanation	Do not accept ← oe
10	(i)		graph of cubic correct way up	B1	**B0** if stops at x-axis	must not have any ruled sections; no curving back; condone slight 'flicking out' at ends but not approaching a turning point; allow max on y-axis or in 1st or 2nd quadrants; condone some 'doubling' or 'feathering' (deleted work still may show in scans)
			crossing x-axis at -3, 2 and 5	B1	on graph or nearby; may be in coordinate form mark intent for intersections with both axes	allow if no graph, but marked on x-axis condone intercepts for x and / or y given as reversed coordinates
			crossing y-axis at 30	B1 **[3]**	or $x = 0$, $y = 30$ seen if consistent with graph drawn	allow if no graph, but eg B0 for graph with intn on y-axis nowhere near their indicated 30
10	(ii)		correct expansion of two of the linear factors	M1	may be 3 or 4 terms	condone lack of brackets if correct expansions as if they were there
			correct expansion and completion to given answer, $x^3 - 4x^2 - 11x + 30$	A1 **[2]**	must be working for this step before given answer	or for direct expansion of all three factors, allow M1 for $x^3 + 3x^2 - 2x^2 - 5x^2 - 6x - 15x + 10x + 30$, condoning an error in one term , and A1 if no error for completion by stating given answer

Question			Answer	Marks	Guidance	Question
10	(iii)		translation $\begin{pmatrix} 0 \\ -36 \end{pmatrix}$	B1 B1 **[2]**	0 for shift or move etc without stating translation or 36 down, or –36 in *y* direction oe	0 if eg stretch also mentioned if conflict, eg between '–36 in *y* direction' and wrong vector, award B0 0 for '–36 down'
10	(iv)		$-1 - 4 + 11 - 6 = 0$ attempt at division by $(x + 1)$ as far as $x^3 + x^2$ in working correctly obtaining $x^2 - 5x - 6$ factorising the correct quadratic factor $x^2 - 5x - 6$, that has been correctly obtained $(x - 6)(x + 1)^2$ oe isw	B1 M1 A1 M1 A1 **[5]**	or **B1** for correct division by $(x + 1)$ or for the quadratic factor found by inspection, and the conclusion that no remainder means that $g(-1) = 0$ or inspection with at least two terms of three–term quadratic factor correct; or finding f(6) = 0 or $(x - 6)$ found as factor for factors giving two terms of quadratic correct or for factors ft one error in quadratic formula or completing square; **M0** for formula etc without factors found for those who have used the factor theorem to find $(x - 6)$, **M1** for working with cubic to find that $(x + 1)$ is repeated condone inclusion of '= 0'	NB examiners must use annotation in this part; a tick where each mark is earned is sufficient M0 for trials of factors to give cubic unless correct answer found with clear correct working, in which case award the M1A1M1A1 allow for $(x - 6)$ and $(x + 1)$ given as factors eg after quadratic formula etc isw roots found, even if stated as factors just the answer $(x - 6)(x + 1)^2$ oe gets last 4 marks

Question			Answer	Marks	Guidance	Question
11	(i)		[radius =] $\sqrt{125}$ isw or $5\sqrt{5}$	B1		
			[C =] (10, 2)	B1 **[2]**	condone $x = 10$, $y = 2$	
11	(ii)		verifying / deriving that (21, 0) is one of the intersections with the axes	B1	using circle equation or Pythagoras; or putting $y = 0$ in circle equation and solving to get 21 and -1; condone omission of brackets	equation may be expanded first
			(−1, 0)	B1		condone not written as coordinates
			(0, −3) and (0, 7)	B2 **[4]**	**B1** each; if B0 for D and E, then **M1** for substitution of $x = 0$ into circle equation or use of Pythagoras showing $125 - 10^2$ or $h^2 + 10^2 = 125$ ft their centre and/or radius	condone not written as coordinates; condone not identified as D and E; condone D = (0, 7), E = (0, −3) – will penalise themselves in (iii)

Question			Answer	Marks	Guidance	Question
11	(iii)		midpt BE = (21/2 , 7/2 ft) oe	B1	ft their E	NB examiners must use annotation in this part; a tick where each mark is earned is sufficient
					or stating that the perp bisector of a chord always passes through the centre of the circle	must be explicit generalised statement; need more than just that C is on this perp bisector
			grad BE = $\frac{7-0}{0-21}$ oe isw	M1	ft their E; M0 for using grad BC (= –2/11)	condone $-1/3x$ oe
			grad perp bisector = 3 oe	M1	for use of $m_1m_2 = -1$ oe soi; ft their grad BE; no ft from grad BC used	condone $3x$ oe; allow M1 for eg $-1/3 \times 3 = -1$
			$y - 7/2 = 3(x - 21/2)$ oe	M1	ft; M0 for using grad BE or perp to BC allow this M1 for C used instead of midpoint	or use of $y = 3x + c$ and subst of (21/2 , 7/2) oe ft
			$y = 3x - 28$ oe	A1	must be a simplified equation	no ft; those who assume that C is on the line and use it to find $y = 3x - 28$ can earn B0M1M1M1A1A0 those who argue that the perp bisector of a chord always passes through the centre of the circle and then uses C rather than midpt of BE are eligible for all 6 marks
			verifying that (10, 2) is on this line	A1	no ft; A0 if C used to find equation of line, unless B1 earned for correct argument	
				[6]		

Question			Answer	Marks	Guidance	Question
12	(i)		$3x^2 + 12x + 13 = 2x + k$	M1	oe eg M1 for $3x^2 + 10x + 13 = k$	condone $3x^2 + 10x + 13 - k = y$ for this M1
			$3x^2 + 10x + 13 - k$ [= 0]	M1	for rearranging to 0; condone one error in adding/subtracting; but M0 for $3x^2 + 10x + 13 = k$ or $3x^2 + 10x + 13 - k = y$	$3x^2 + 10x + 13 - k$ [= 0] will also earn the first M1 if a separate statement has not already done so
			$b^2 - 4ac > 0$ oe soi	M1	may be earned near end with correct inequality sign used there	allow '$b^2 - 4ac$ is positive' oe; 0 for just 'discriminant > 0' unless implied by later work
			$100 - 4 \times 3 \times (13 - k)$ (> 0) oe	M1	for correct substitution ft into $b^2 - 4ac$, dep on second M1 earned; brackets / signs must be correct	can be earned with equality or wrong inequality, or in formula M0 for trials of values of k in $b^2 - 4ac$
			$k > 14/3$ oe	A1	accept $k >$ 56/12 or better, isw incorrect conversion of fraction but not wrong use of inequalities if A0, allow **B1** for 56/12 oe obtained with equality or wrong inequality (ie 3rd M1 has not been earned)	
				[5]		

Question			Answer	Marks	Guidance	Question
12	(ii)		$3(x + 2)^2 + 1$ www as final answer	B4	**B1** for $a = 3$ and **B1** for $b = 2$ and **B2** for $c = 1$ or **M1** for $13 - 3 \times$ their b^2 or for $13/3 -$ their b^2 or **B3** for $3\left[(x+2)^2 + \frac{1}{3}\right]$	condone omission of square symbol; ignore equating to zero in working or answer
			y-minimum = 1 [hence curve is above x-axis]	B1 **[5]**	Stating min pt is (–2, 1) is sufft allow ft if their $c > 0$ B0 for only showing that discriminant is negative oe; need also to justify that it is all above not all below x-axis B0 for stating min point = 1 or ft	must be done in this part; ignore wrong x-coordinate
12	(iii)		5 cao	B2 **[2]**	**M1** for substitution of their (–2, 1) in $y = 2x + k$	allow M1 ft their $3(x + 2)^2 + 1$; or use of (–2,1) found using calculus; M0 if they use an incorrect minimum point inconsistent with their completed square form

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