

Mathematics (MEI)

Advanced Subsidiary GCE

Unit **4752**: Concepts for Advanced Mathematics

Mark Scheme for June 2013

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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.

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1. Annotations and abbreviations

Annotation in scores	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

2. 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	(i)	$-10x^{-6}$ isw	B1 B1 [2]	for -10 for x^{-6} ignore $+c$ and $y =$	if B0B0 then SC1 for $-5 \times 2x^{-5-1}$ or better soi
1	(ii)	$y = x^{\frac{1}{3}}$ soi kx^{n-1} $\frac{1}{3}x^{-\frac{2}{3}}$ isw	B1 M1 A1 [3]	condone $y' = x^{\frac{1}{3}}$ if differentiation follows ft their fractional n ignore $+c$ and $y =$	allow 0.333 or better
2	(i)	11.5, 11 and 10.5 oe arithmetic and/or divergent	B1 B1 [2]	allow AP ignore references to a , d or n	ignore labelling incorrect embellishments such as converging arithmetic..., diverging geometric... do not score. B0 if a choice is given eg AP/GP.
2	(ii)	$n = 30$ identified as number of terms in relevant AP $S_{30} = \frac{30}{2}(2 \times 11.5 + (30-1) \times -0.5)$ 127.5 oe	B1 M1 A1 [3]	or $S_{30} = \frac{30}{2}(11.5 + -3)$ allow recovery from slip in working (eg omission of minus sign)	eg $1 + 2 + 3 + \dots + 30$ is not a relevant AP condone one error in a , d or n but do not condone $l = -\frac{1}{2}$ SC3 if each term calculated and summed to correct answer or for 127.5 unsupported
3		kx^{-2} $-9x^{-2}$ $+2x + c$ substitution of $x = 3$ and $y = 6$ in their expression following integration $c = 1$	M1* A1 M1* M1dep A1 [5]	may be awarded later c may appear at substitution stage on award of either of previous M1s A0 if spoiled by further working	$k \neq 0$ no marks at all for responses based on " $mx + c$ " eg $6 = k3^{-2} + 2 \times 3 + c$ for full marks, must see " $y =$ " at some stage

Question		Answer	Marks	Guidance	
4	(i)	<p>clear diagram or explanation starting with equilateral triangle correctly showing 30 as half angle and sides 1 and 2 or multiples of these lengths</p> <p>correct use of Pythagoras <i>and</i> adjacent and hypotenuse correctly identified to obtain given result $\cos 30^\circ = \frac{\sqrt{3}}{2}$</p>	B1 B1 [2]		units for sides and angle not required condone abbreviations
4	(ii)	$\pm \frac{\pi}{6}$ or $-\frac{5\pi}{6}$ soi $\frac{11\pi}{6}$ $\frac{7\pi}{6}$	M1 A1 A1 [3]	may be implied by correct answer or $\pm 0.523598775\dots$, or may appear on quadrant diagram or graph if A0A0, SC1 for 1.8333333 π and 1.16666666 π to 3 or more sf or SC1 for 330° and 210° www	condone $\pm 30^\circ$ or -150° ignore extra values outside the range if full marks or SC1 awarded, subtract 1 for extra values <i>in</i> the range
5	(i)	ruled line touching curve at $x = 2$ their $\frac{y_2 - y_1}{x_2 - x_1}$ from their <i>tangent</i> answer in range 2.5 to 3.0 inclusive	M1 M1 A1 [3]	may be on graph or in working; must use correct points from their line their tangent may be at another point both M1 s must be awarded	intent to touch, but must not clearly cut curve M0 for reciprocal, (value is approx 2.773)
5	(ii)	3.482202253... and 4.59479342... rot to 3 or more sf 2.78 to 2.7815 or 2.8	B1 B1 [2]	mark the final answer	2.781477917..

Question		Answer	Marks	Guidance	
6	(i)	$2S$ cao	B1 [1]		
6	(ii)	$\frac{a}{1-r^2}$ $\frac{S}{1+r}$ or $\frac{1}{1+r}S$	M1 A1 [2]	if M0, SC1 for $\frac{1-r}{1-r^2} \times S$ oe	
7		$h = 1.5$ $\frac{1.5}{2} \times (2.3 + 2(2.9 + 4 + 4.6 + 4.2 + 3) + 0)$ all y -values correct and correctly placed in formula 29.775 to 3 sf or better; isw	B1 M1 B1 A1 [4]	$h = 1.5$ basic shape of formula correct, omission of brackets may be recovered later condone omission of outer brackets and/or omission of 0 answer only does not score	allow if used with 6 separate trapezia at least 4 y -values in middle bracket, eg $\frac{1.5}{2} \times (2.3 + 2(2.9 + 4 + 4.6 + 4.2) + 3)$ M0 if any x values used or B1 + B3 if 6 separate trapezia calculated to give correct answer
8	(i)	graph from $(-1, 1)$ to $(1, 1)$ to $(2, 2)$ to $(3, 0)$	2 [2]	B1 for three points correct or for all four points correct but clearly not joined	points must be joined, but not always easy to see, so BOD if in doubt. Accept freehand drawing.
8	(ii)	graph from $(-2, 3)$ to $(2, 3)$ to $(4, 6)$ to $(6, 0)$	2 [2]	B1 for three points correct or for all four points correct but clearly not joined	points must be joined, but not always easy to see, so BOD if in doubt. Accept freehand drawing.

Question		Answer	Marks	Guidance	
9	(i)	$3x^2 - 6x - 22$ their $y' = 0$ so 3.89 -1.89	M1 M1 A1 A1 [4]	condone one incorrect term, but must be three terms at least one term correct in their y' if A0A0, SC1 for $\frac{3 \pm 5\sqrt{3}}{3}$ or $1 \pm \frac{5}{\sqrt{3}}$ or better, or both decimal answers given to a different accuracy or from truncation	condone " $y =$ " may be implied by use of eg quadratic formula, completing square, attempt to factorise 3.886751346 and -1.886751346
9	(ii)	$x^3 - 3x^2 - 22x + 24 = 6x + 24$ $x^3 - 3x^2 - 28x [= 0]$ other point when $x = 7$ isw	M1 M1 A1 [3]	may be implied by $x^3 - 3x^2 - 28x [= 0]$ may be implied by $x^2 - 3x - 28 [= 0]$ dependent on award of both M marks	ignore other values of x
9	(iii)	$F[x] = \frac{x^4}{4} - \frac{3x^3}{3} - \frac{22x^2}{2} + 24x$ $F[0] - F[-4]$ area of triangle = 48 area required = 96 from fully correct working	M1* M1dep B1 A1 [4]	allow for three terms correct; condone $+ c$ allow $0 - F[-4]$, condone $- F[-4]$, but do not allow $F[-4]$ only A0 for -96, ignore units,	alternative method M1 for $\int ((x^3 - 3x^2 - 22x + 24) - (6x + 24))dx$ may be implied by 2 nd M1 M1* for $F[x] = \frac{x^4}{4} - \frac{3x^3}{3} - \frac{28x^2}{2}$ condone one error in integration M1dep for $F[0] - F[-4]$ no marks for 96 unsupported

Question		Answer	Marks	Guidance
10	(i) (A)	$AC^2 = 12.8^2 + 7.5^2 \text{ oe}$ $AC = 14.83543056..$ $\tan C = 12.8/7.5$ $\text{or } C = 90 - \tan^{-1}(7.5/12.8) \text{ oe}$ <p>59.6 to 59.64</p> $\frac{AD}{\sin(155 - \text{their}59.6)} = \frac{\text{their}14.8}{\sin 35} \text{ oe}$ $25.69 \text{ to } 25.8$	M1 allow correct application of cosine rule or from finding relevant angle and using trig A1 rot to 3 or more sf , or 15 M1 or $\sin C = 12.8/\text{their}14.8$ or $\cos C = 7.5/\text{their}14.8$ A1 M1 A1 allow B2 for $25.69 \leq AD < 25.8$ unsupported....but B0 for 25.8 unsupported [6]	B2 for 14.8 or better unsupported or $\frac{\sin C}{12.8} = \frac{\sin 90}{\text{their}14.8}$ or $\cos C = \frac{\text{their}14.8^2 + 7.5^2 - 12.8^2}{2 \times 7.5 \times \text{their}14.8}$ M0A0 for $14.8/\cos 55 = 25.803\dots$

Question		Answer	Marks	Guidance	
10	(i) (B)	area of $ABC = 48$ soi $\frac{1}{2} \times \text{their } 14.8 \dots \times \text{their } 25.7 \dots \times \sin(\text{their } 59.6 - 10)$ 192.8 to 194 [m^2]	B1 M1 A1 [3]	may be implied by correct final answer in range or by sight of $\frac{1}{2} \times 12.8 \times 7.5$ oe may be implied by 144.8 to 146 B3 for correct answer in range if unsupported	condone 48.0...
10	(ii)	angle $HMG = \frac{\pi - 1.1}{2}$ or $MHG = 0.55$ (31.5126°) $HM = 1.7176$ to 1.7225 $\frac{1}{2} \times 1.1 \times \text{their } HM^2$ or $\frac{\theta}{360} \times \pi \times \text{their } HM^2$ area of triangle $EMF = 0.652$ to 0.662 2.95 to 2.952 [m^2] cao	B1 B1 M1 B1 A1 [5]	or angle EMF or angle MEF 1.63(0661924...) $\theta = 63(.025357\dots)$ or MGH	allow 1.02 to 1.021 or 58.487° to 58.5° may be implied by final answer check arithmetic if necessary their $HM \neq 0.9$ or 1.8 may be implied by final answer or in double this (1.304 to 1.324) full marks may be awarded for final answer in correct range ie allow recovery of accuracy
11	(i)	$65 \times (1 - 0.017)^3$ oe 61.7410... showing more than 3 sf	M1 A1 [2]	may be longer method finding decrease year by year etc answer 61.7 given	NB use of 3×0.017 leads to 61.685, which doesn't score
11	(ii)	$[d =] 65 \times 0.983^n$ oe	B1 [1]	eg $63.895 \times 0.983^{n-1}$ or $61.7 \times 0.983^{n-3}$	

Question		Answer	Marks	Guidance	
11	(iii)	$65 \times 0.983^n < 3 \text{ or}$ $\log_{10}(65 \times 0.983^n) < \log_{10}3 \text{ oe}$ $\log_{10}65 + n \log_{10}0.983 < \log_{10}3 \text{ www}$ $[\log_{10}65 + n \log_{10}0.983 < \log_{10}3]$ $n \log_{10}0.983 < \log_{10}3 - \log_{10}65 \text{ and}$ $\text{completion to } n > \frac{\log_{10}3 - \log_{10}65}{\log_{10}0.983} \text{ AG www}$ $n = 180 \text{ cao}$	M1* M1dep A1 B1 [4]	<p>may be implied by eg $\log_{10}65 + n \log_{10}0.983 < \log_{10}3$</p> <p>or $[\log_{10}0.983^n < \log_{10}3 - \log_{10}65]$</p> <p>inequality signs must be correct throughout</p> <p>B0 for $n > 180$</p>	condone omission of base 10 throughout if M0M0, SC1 for $\log_{10}65 + n \log_{10}0.983 < \log_{10}3$ even if $<$ is replaced by eg = or $>$ with no prior incorrect log moves NB watch for correct inequality sign at each step reason for change of inequality sign not required $n > 179.38\dots$
11	(iv)	$63.895 = 65 \times 10^{-k} \text{ soi}$ $\log_{10}(\text{their } 63.895) = \log_{10}65 - k$ $\text{or } -k = \log_{10}(\text{their } 0.983)$ $[k =] 7.4 \times 10^{-3} \text{ to } 7.45 \times 10^{-3}$ $[d =] 42.1\dots \text{ to } 42.123 [\text{ }^{\circ}\text{C}] \text{ isw}$	B1 M1 A1 A1 [4]	or $65 \times 0.983 = 65 \times 10^{-k}$ <p>their 63.895 must be from attempt to reduce 65 by 1.7% at least once</p> <p>$[k =] -\log_{10}0.983$ isw</p>	accept 63.895 rot to 3 or 4 sf; B1 may be awarded for substitution of $t = 1$ after manipulation M1A1A1 may be awarded if other value of t with correct d is used NB B1M1A0A1 is possible; unsupported answers for k and/or d do not score

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