OCR
Oxford Cambridge and RSA

GCE

Mathematics (MEI)

Unit **4752**: Concepts for Advanced Mathematics

Advanced Subsidiary GCE

Mark Scheme for June 2018

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

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	(i)		$kx^{\frac{1}{2}-1}$ $3x^{-\frac{1}{2}}$ oe simplified form isw	M1 A1 **[2]**	k is any non-zero constant, ignore + c **A0** for e.g. $3x^{-\frac{1}{2}} + c$	**B2** for correct answer unsupported
1	(ii)		$kx^{\frac{5}{2}+1}$ $10x^{\frac{7}{2}}$ isw + c	M1 A1 A1 **[3]**	k is any non-zero constant seen at least once following integration	 allow any equivalent exact, simplified form
2	(i)		$910 = \frac{50}{2}(2\times 3.5+(50-1)d)$ oe 0.6 or $\frac{3}{5}$	M1 A1 **[2]**	if $u_{50} = 32.9$ found first, **M1** for $32.9 = 3.5+(50-1)d$ oe	**B2** for correct answer unsupported
2	(ii)		for correct substn. into formula for sum of GP e.g. $S = \frac{25(1.6^{12}-1)}{1.6-1}$ 11686 cao	M1 A1 **[2]**	 **B1** for 11686.457 unsupported **B2** for 11686 unsupported	
3	(i)		$\frac{1}{2}, \frac{\sqrt{3}}{2}, 1, \frac{\sqrt{3}}{2}$	B2 **[2]**	**B1** for two terms correct	**NB** exact form required

Question			Answer	Marks	Guidance	
3	(ii)		e.g. period of sin x = 2π so sequence repeats each time a multiple of 2π is reached	B1	or **B1** for at least the next 9 terms: $\frac{1}{2}, 0, -\frac{1}{2}, -\frac{\sqrt{3}}{2}, -1, -\frac{\sqrt{3}}{2}, -\frac{1}{2}, 0, \frac{1}{2}$... to show repetition **SC1** if they have worked with decimals: at least the next 9 terms following the first 4, all rot to 3sf or better	Alternative acceptable statements for **B1**: $\sin\theta$ is periodic so $\sin(\frac{n\pi}{6})$ must also be periodic; $\sin\left(\frac{n\pi}{6}+2\pi\right)=\sin\left(\frac{n\pi}{6}\right)$ (so $\sin\left(\frac{n\pi}{6}\right)$ is periodic)
			12	B1 **[2]**	Repeats after 12 terms or on the 13th term	
4			$r\theta = 12$ **and** $\frac{1}{2}r^2\theta = 45$ oe	M1*	or $12 = \frac{2\pi r\theta}{360°}$ **and** $45 = \frac{\pi r^2\theta}{360°}$	
			eliminating a variable e.g. $\frac{1}{2}r = \frac{45}{12}$ or $\frac{1}{2}\times 12 \times r = 45$	M1dep*	e.g. $\frac{45}{12} = \frac{1}{2}r$ or $45 = \frac{1}{2}\times 12 \times r$	
			r = 7.5 [cm] **and** θ = 1.6	A1		**NB** angle in degrees: 91.67…
			$45 - \frac{1}{2}$ *their* $r^2 \times \sin$ *their* θ	M1		or **M1** for $45 - \frac{1}{2}$ *their AB* × *their perp ht* ft *their r* and *their* θ **NB** *AB* = 10.76034… *perp ht* = 5.2253…
			area of segment = 16.8 to 16.9 [cm^2]	A1 **[5]**		

Question			Answer	Marks	Guidance	
5			$H = 0.5$ soi	B1		
			$\frac{h}{2}\times\left[2.0+1.7+2\left(2.1+2.3+2.4+2.1\right)\right]$	M1	correct formula used with 3,4 or 5 strips and numerical value for h; condone omission of outer brackets for M marks, allow recovery	
			all y values placed correctly	M1	**M0** if any x values used	**NB** 5 trapezia areas are: 1.025, 1.1, 1.175, 1.125, 0.95
			5.375 oe to 2 sf or more	A1	if **M0M0** allow **B3** for 5.375 and **B1** 1.11 to 1.12	
			[amount of paint] = 1.11 to 1.12 isw	A1		
				[5]		
6			$\sin^2\theta = 1 - \cos^2\theta$ used	M1		or $\cos^2\theta = 1 - \sin^2\theta$ substituted in $6\cos^2\theta + \cos\theta - 1 = 0$
			eg $\cos\theta + 5 = 6(1 - \cos^2\theta)$ or better		at least one correct intermediate step to obtain **given** answer	to obtain $\cos\theta + 5 = 6\sin^2\theta$ with at least one correct intermediate step
			$6\cos^2\theta + \cos\theta - 1 = 0$ www	A1		
			$-\frac{1}{2}$ and $\frac{1}{3}$ found	B1	both required; allow 0.33 or better	
			$\theta = \frac{2\pi}{3}, \frac{4\pi}{3}$, 1.23 , 5.05 correctly rot to 2 dp or more isw	B2	**B1** for 2 correct, to 2 dp or more if **B0** allow **SC1** for all four answers in degrees correctly rot to 2dp or more with no extras: 120, 240, 70.528…,289.47…	if **B2** deduct 1 mark for extra values in range; ignore extra values outside range **NB** 2.094395…, 4.18879…, 1.230959…, 5.052225…
				[5]		

Question			Answer	Marks	Guidance	
7			$(x + 2)\log_{10} 5 = x\log_{10} 3$	M1	**M1** for $x + 2 = x\log_5 3$ or **M1** $(x + 2)\log_3 5 = x$	condone omission of base 10 throughout accept decimal equivalents to 2sf allow recovery of omission of brackets in later working
			$(\log_{10} 5 - \log_{10} 3)x = -2\log_{10} 5$ oe	M1	for correct rearrangement to $kx = c$ in either exact or decimal form **M1** $(\log_5 3 - 1)x = 2$ oe or **M1** $(1 - \log_3 5)x = 2\log_3 5$ oe	
			-6.30 cao www	A1 **[3]**		
8	**(i)**		$a + d = 40$ **and** $a + 3d = 250$ oe	M1	or for $2d = 250\text{-}40$ oe **and** use of one of $a +$ *their* $d = 40$ or $a + 3\times$*their* $d = 250$	**B2** for $a = -65$ unsupported **NB** $d = 105$
			$a = -65$	A1 **[2]**		
	(ii)		For GP , $ar = 40$ **and** $ar^3 = 250$ oe $a = \pm 16$ isw	M1 A2 **[3]**	**A1** for one value of a correct or **B1** for both values of r found: ± 2.5	if **M0** **B2** for one of $a = \pm 16$, **B3** for both

Question			Answer	Marks	Guidance	
9	(i)		(F[x]) = $-\frac{x^4}{4}+\frac{2x^3}{3}+\frac{5x^2}{2}-6x$ oe	M2	**M1** for 3 correct terms ignore + *c* for **M** marks	**NB** accept coeff to 3sf or better -0.25, 0.667, 2.5
			evidence of F[1] - F[-2] used: e.g $-\frac{37}{12}-\frac{38}{3}$ or -3.0833… - 12.666…	M1	dep at least two terms correctly integrated	**M0** if they have differentiated
			-15.75 oe isw	A1	if -15.75 seen after fully correct integral function obtained, award **M1A1** **A0** for -15.75 + c	-15.75 unsupported does not score
			The area between the curve and the *x*-axis, from $x = -2$ to $x = 1$(is 15.75)	B1 **[5]**		Can extend the argument further, e.g. area between curve and *x*-axis from $x = -2$ to $x = 1$, region is below axis, hence negative
9	(ii)		$\frac{dy}{dx}=-3x^2+4x+5$	M1	All correct	
			'their' $\frac{dy}{dx}=0$ soi	M1	ft provided attempt at differentiation	
			valid method for solving *their* 3 term quadratic	M1		can be implied by 2.1196… , -0.78629…
			$[x=]\frac{4\pm\sqrt{76}}{6}, \frac{2}{3}\pm\frac{\sqrt{19}}{3}$ oe exact	A1		
			$x<\frac{4-\sqrt{76}}{6}$, $x>\frac{4+\sqrt{76}}{6}$ oe exact	A1ft **[5]**	allow ≤ and ≥ used ft their exact roots	A0 for $\frac{4-\sqrt{76}}{6} > x > \frac{4+\sqrt{76}}{6}$ oe
9	(iii)		$\frac{4\pm\sqrt{76}}{12}$ oe	B1ft	ft *their* roots, to 3sf or better	can be implied by 1.0598… , - 0.3931…
			(0, −6) cao	B1 **[2]**		

Question			Answer	Marks	Guidance	
10	(i)		$\frac{dy}{dx} = 1 + \frac{1}{x^3}$ oe $\frac{d^2y}{dx^2} = -3x^{-4}\left(= -\frac{3}{x^4}\right)$ www	M1 A1 **[2]**	 but not just $-\frac{3}{x^4}$ as **AG**	use of $\int \frac{d^2y}{dx^2}dx$ does not score
10	(ii)		*their* $\frac{dy}{dx} = 0$ soi Solving to get $x = -1$ as the only solution $-\frac{3}{(their\ negative\ x)^4}$ *their* -3 < 0 (∴ maximum)	M1 A1 B1ft **[3]**	provided *their* $\frac{dy}{dx}$ is of the form $a + bx^n$ or using negative x values to consider signs of gradient either side of $x = -1$, signs for gradients identified to verify maximum	 accept a convincing argument that $\frac{d^2y}{dx^2}$ is always negative, ∴ any turning point must be a maximum
10	(iii)	(A)	$y = 0.5$ when $x = 1$ subst $x = 1$ into *their* $\frac{dy}{dx}$ **and** either of: y – *their* 0.5 = *their* $\frac{dy}{dx} \times (x - 1)$ or *their* 0.5= *their* $\frac{dy}{dx} \times 1 + c$ and completion to given answer	B1 M1 A1 **[3]**	 	 $y = 2x - 1.5$ **AG**

Question			Answer	Marks	Guidance	
10	(iii)	(*B*)	$2x-1.5=x-\frac{1}{2x^2}$ $2x^3-3x^2+1=0$ AG	M1 A1	and completion to given answer with at least one intermediate step	
			$x=-\frac{1}{2}$ oe	B1		
			$y=-\frac{5}{2}$ oe	B1 **[4]**		
11	(i)		GDP in 2010, in billions	B1 **[1]**	date and billions both required	
11	(ii)		$\log_{10} G=\log_{10} 6100+t\log_{10}\left(1+\frac{r}{100}\right)$ www	B1	condone omission of log base	
			clear comparison with equation of straight line	B1 **[2]**	e.g. in the form y = c + xm, consistent with their correct log equation; or this is in the form of a straight line with gradient = $\log_{10}\left(1+\frac{r}{100}\right)$ and y intercept = $\log_{10} 6100$	
11	(iii)		3.88, 3.93, 3.98, 4.02, 4.04 correctly rounded to 3sf or more	B1	3.8792…, 3.9325…, 3.9825…, 4.0204…, 4.0417…	
			all values correct and pts plotted accurately	B1	Condone 1 error, see overlay (tolerance 1mm, 1/2 a square)	
			ruled line of best fit drawn from at least t=1 to t=5 inclusive	B1 **[3]**	Line must not go outside overlay between t=1 and t=5	**NB** line between (1, 3.87) and (1, 3.89) at lower limit and between (5, 4.04) and (5, 4.06) at upper limit

Question			Answer	Marks	Guidance	
11	(iv)		correct method for gradient of line e.g. evaluation of $\frac{\log G_2 - \log G_1}{t_2 - t_1}$ 0.035 to 0.05 $1+\frac{r}{100} = 10^{\text{their gradient}}$ $9.14 \leq r \leq 11.7$	M1 A1 M1 A1 **[4]**	May be implied by e.g. *m* between 0.035 to 0.05 $(t_1,\ \log G_1)$ and $(t_2,\ \log G_2)$ are points on *their* line or **M1** for substitution of $(t_1,\ \log G_1)$ in $\log_{10} G = \log_{10} 6100 + t\log_{10}\left(1+\frac{r}{100}\right)$ **M1** for making $1+\frac{r}{100}$ the subject **A1** for $1+\frac{r}{100}$ = 1.0839 to 1.1220 **A1** $9.14 \leq r \leq 11.7$	condone use of values from table for either approach if **M0A0M0** allow **SC4** for using a pair of values from *their* line, finding *G* and using in: $G = 6100\left(1+\frac{r}{100}\right)^t$ and evaluating www to give *r* in range
11	(v)		12300 to 14800 Comment on: Reliability of continuing constant average annual growth rate unreliable as it is extrapolation exponential growth model for GDP which may be unreasonable	B1 B1 **[2]**	e.g. unreliable as no guarantee that the growth rate will not vary significantly during the 3 years after 2015 no guarantee that pattern will continue outside the range of data	

OCR (Oxford Cambridge and RSA Examinations)
The Triangle Building
Shaftesbury Road
Cambridge
CB2 8EA

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553