OCR
Oxford Cambridge and RSA

Wednesday 17 May 2017 – Morning

AS GCE MATHEMATICS (MEI)

4751/01 Introduction to Advanced Mathematics (C1)

QUESTION PAPER

5203606504

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4751/01
- MEI Examination Formulae and Tables (MF2)

Other materials required:
None

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the barcodes.
- You are **not** permitted to use a calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

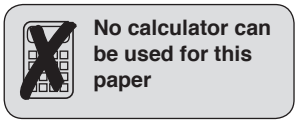
INFORMATION FOR CANDIDATES

This information is the same on the Printed Answer Book and the Question Paper.

- The number of marks is given in brackets **[ ]** at the end of each question or part question on the Question Paper.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.



Section A (36 marks)

1 A straight line passes through (0, 1) and has gradient −2. Draw the graph of this line on the grid. **[2]**

2 **(i)** Find the value of $\left(1\frac{7}{9}\right)^{-\frac{1}{2}}$. **[3]**

(ii) Simplify $\dfrac{(6x^5y^2)^3}{18y^{10}}$. **[2]**

3 Solve the inequality $6-x > 5(x-3)$. **[3]**

4 Find the coordinates of the point of intersection of the lines $2x + 5y = 5$ and $x - 2y = 4$. **[4]**

5 The equation of a circle is $(x + 2)^2 + (y - 3)^2 = 5$.

(i) State the radius of this circle and the coordinates of its centre. **[2]**

(ii) Find the equation of the line through the centre of the circle which is parallel to the line $5x + y = 4$. **[2]**

6 Rearrange the formula $r = \sqrt{\dfrac{V}{a+b}}$ to make b the subject. **[4]**

7 **(i)** Simplify $\dfrac{5-2\sqrt{7}}{3+\sqrt{7}}$, giving your answer in the form $\dfrac{a-b\sqrt{7}}{c}$, where a, b and c are integers. **[3]**

(ii) Simplify $\dfrac{12}{\sqrt{2}} + \sqrt{98}$, giving your answer in the form $d\sqrt{2}$, where d is an integer. **[2]**

8 You are given that, in the expansion of $(a + bx)^5$, the constant term is 32 and the coefficient of x^3 is −1080. Find the values of a and b. **[5]**

9 The smallest of three consecutive positive integers is n. Find the difference between the squares of the smallest and largest of these three integers, and hence prove that this difference is four times the middle one of these three integers. **[4]**

Section B (36 marks)

10

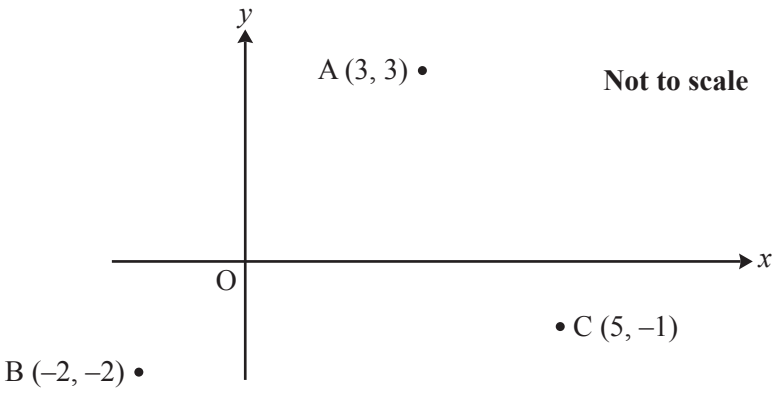


Fig. 10

Fig. 10 shows the points A (3, 3), B (−2, −2) and C (5, −1).

(i) Show that AB = BC. **[2]**

(ii) Find the equation of the line through B which is perpendicular to AC. Give your answer in the form $y = mx + c$. **[4]**

(iii) Find the coordinates of point D such that ABCD is a rhombus. **[2]**

(iv) Determine, showing all your working, whether the point E (8, 3.8) lies inside or outside the rhombus ABCD. **[4]**

11 A cubic function f(x) is given by f(x) = (x − 2)(2x − 3)(x + 5).

(i) Sketch the graph of y = f(x). **[3]**

(ii) The curve y = f(x) is translated by $\begin{pmatrix} -3 \\ 0 \end{pmatrix}$. The equation of the translated curve is y = g(x). Show that g(x) = $2x^3 + 21x^2 + 43x + 24$. **[3]**

(iii) Show that $x = -2$ is one root of the equation g(x) = 6 and hence find the other two roots of this equation, expressing your answers in exact form. **[6]**

12 **(i)** Express $y = x^2 + x + 3$ in the form $y = (x + m)^2 + p$ and hence explain why the curve $y = x^2 + x + 3$ does not intersect the x-axis. **[4]**

(ii) Find the coordinates of the points of intersection of the curves $y = x^2 + x + 3$ and $y = 2x^2 - 3x - 9$. **[4]**

(iii) Find the set of values of k for which the curves $y = x^2 + x + k$ and $y = 2x^2 - 3x - 9$ do **not** intersect. **[4]**

END OF QUESTION PAPER

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4751/01 Introduction to Advanced Mathematics (C1)

PRINTED ANSWER BOOK

Candidates answer on this Printed Answer Book.

OCR supplied materials:
- Question Paper 4751/01 (inserted)
- MEI Examination Formulae and Tables (MF2)

Other materials required:
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Duration: 1 hour 30 minutes

4751101

5203677505

Candidate forename		Candidate surname	

Centre number						Candidate number				

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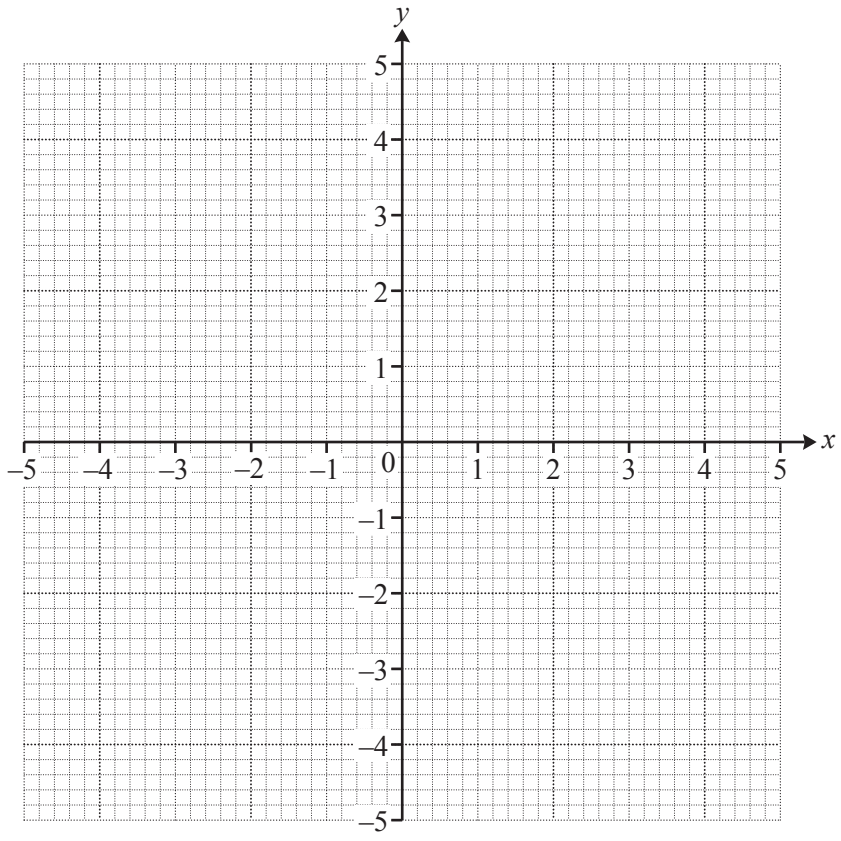
No calculator can be used for this paper

Section A (36 marks)

1



2 (i)

2 (ii)

3	
4	
5 (i)	

5 (ii)

6

7 (i)

7 (ii)

8

9

Section B (36 marks)

10 (i)	
10 (ii)	
10 (iii)	

10 (iv)

11 (i)	
11 (ii)	

11 (iii)	

12 (i)

12 (ii)

12 (iii)	

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

OCR
Oxford Cambridge and RSA

GCE

Mathematics (MEI)

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

Advanced Subsidiary GCE

Mark Scheme for June 2017

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.

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

Annotations and abbreviations

Annotation in scoris	Meaning
BP	Blank Page – this annotation **must** be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
✓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			correct ruled line of intercept (0, 1) and gradient −2 drawn on grid, extending at least from (−1.5, 4) to (2, −3), as per the circles on the overlay, tol. 1mm horizontally (ie half a square on the grid)	2 **[2]**	**M1** for correct line but eg not extending into 4th quadrant or **M1** for line with correct gradient but wrong intercept or **M1** for line with correct intercept and gradient negative but not −2 or **M1** for correct plots but line not ruled	NB page 12 shown in this image must be annotated as BP if blank. Highlight (to indicate seen) in q1 image of page 12 if just rough work crossed out. If a qn number is shown and relevant work seen, highlight the qn no in the q1 image then use full response view to link page 12 to relevant question; also put a highlight by the image in the correct qn space to remind you there is extra work to look at.
2	(i)		$\frac{3}{4}$ oe	3 **[3]**	**B2** for $\frac{3}{a}$ or $\frac{c}{4}$ or $\pm\frac{3}{4}$ or **M2** for $\left(\frac{4}{3}\right)^{-1}$ or $\left(\frac{9}{16}\right)^{\frac{1}{2}}$ or $\sqrt{\frac{9}{16}}$ or **M1** for $\frac{1}{\left(1\frac{7}{9}\right)^{\frac{1}{2}}}$ or $\left(\frac{16}{9}\right)^{-\frac{1}{2}}$ or $\frac{4}{3}$	isw wrong conversion to decimals
2	(ii)		$12x^{15}y^{-4}$ or $\frac{12x^{15}}{y^4}$	2 **[2]**	**B1** for two elements correct if B0, allow **M1** for expanded numerator = $6^3x^{15}y^6$ or $216x^{15}y^6$	
3			$6 - x > 5x - 15$	M1		the first two Ms may be earned with an equation or wrong inequality

Question			Answer	Marks	Guidance	
			$21 > 6x$ or $-6x > -21$ oe or ft	M1	for correctly collecting x terms on one side and number terms on the other and simplifying	ft wrong first step
			$x < \frac{21}{6}$ or $\frac{21}{6} > x$ oe isw or ft	M1	ft their ax [inequality] b, where $b \neq 0$ and $a \neq 0$ or ± 1	award 3 marks only if correct answer obtained after equations or inequalities are used with no errors
				[3]		
4			$2(4 + 2y) + 5y = 5$ oe in x or $2x - 4y = 8$ oe	M1	for subst to eliminate one variable; condone one error; or for multn or divn of one or both eqns to get a pair of coeffts the same, condoning one error	
			$9y = -3$ or $9x = 30$ oe	M1	for collecting terms and simplifying; condoning one error ft or for appropriate addn or subtn to eliminate a variable, condoning an error in one term; if subtracting, condone eg x instead of 0 if no other errors	
			$\left(\frac{30}{9}, -\frac{3}{9}\right)$ oe isw	A2	or $x = 30/9$, $y = -3/9$ oe isw eg $x = 10/3$, $y = -1/3$ allow **A1** for each coordinate	
				[4]		
5	**(i)**		[centre] $(-2, 3)$ [radius] $\sqrt{5}$	B1 B1	**B0 for** $\pm\sqrt{5}$	
				[2]		
5	**(ii)**		$5x + y = -7$ or $y = -5x - 7$ or $5x + y + 7 = 0$	2	**M1** for $5x + y = k$, $k \neq 4$ or for gradient of parallel line $= -5$ or for answer $-5x - 7$	if wrong centre in 5(i), can earn just M1
				[2]		

Question			Answer	Marks	Guidance	
6					each M1 is for a correct, constructive step following through correctly from previous step	
			$r^2 = \dfrac{V}{a+b}$	M1	for squaring both sides	
			$r^2(a+b) = V$ or $r^2a + r^2b = V$	M1	for multiplying both sides by denominator for this and all subsequent Ms, ft for equiv difficulty	allow candidates to combine two or three stages in one working statement eg award first two Ms for $r^2(a+b) = V$ seen as first step
			$r^2b = V - r^2a$ or $a + b = \dfrac{V}{r^2}$	M1	for getting *b* term on one side, other terms on other side	3rd and 4th M1s may be earned in opposite order, as in second answer for these M1s
			$b = \dfrac{V - r^2a}{r^2}$ or $b = \dfrac{V}{r^2} - a$ as final answer	M1 **[4]**	for dividing by coefficient of *b* award 4 marks only if working is fully correct, with at least one interim step. allow **SC2** if there is no working, just the correct answer	where rhs has two terms in the numerator, the division line must clearly extend under both terms
7	(i)		$\dfrac{29 - 11\sqrt{7}}{2}$ isw	3 **[3]**	**B1** for each element; condone written as two separate fractions if 0, allow **M1** for three terms correct in $15 - 5\sqrt{7} - 6\sqrt{7} + 14$ or for attempt to multiply both denominator and numerator by $3 - \sqrt{7}$	
7	(ii)		$13\sqrt{2}$	2 **[2]**	**M1** for $\dfrac{12}{\sqrt{2}} = 6\sqrt{2}$ soi or for $\sqrt{98} = 7\sqrt{2}$ soi or for $\dfrac{12+14}{\sqrt{2}}$ oe	

Question			Answer	Marks	Guidance	
8			$a^5 = 32$	B1	must have evidence that they have considered the constant term	NB examiners must use annotation in this part; a tick where each mark is earned is sufficient
			$a = 2$	B1	**B0** for $a = \pm 2$, but allow them to gain all marks for b if earned	
			$10a^2b^3$ [$= -1080$]	B1	may include x^3 on both sides, or $(bx)^3$ on left and x^3 on right; may have subst their a^2; condone poor notation with inconsistent xs.	B0 for eg $10a^2bx^3 = -1080x^3$
			$4b^3 = -108$ oe	B1	for subst $a = 2$ in $10a^2b^3 = -1080$ oe	B0 for $4b^3 = -108x^3$ etc
			$b = -3$	B1	if 0 in qn, allow **B1** for 1 5 10 10 5 1 row of Pascal's triangle seen or for ${}^5C_3 = 10$	those trialling factors of -108: Allow up to 3 marks (B0,B1,B1 if earned,B0,B1) for reaching $a = 2$ and $b = -3$ with trialling unless explicit reference to 32 in checking, in which case award up to full marks (in effect explicit reference showing their solution fits both constraints triggers 1st and 4th B1s)
				[5]		

9			n $n+1$ $n+2$ soi	B1	may be earned later	
			$(n+2)^2 - n^2$ soi	M1	allow ft for next three marks for other general consecutive integers eg $n-1$ n $n+1$ for other integers in terms of n (eg $2n, 2n+1, 2n+2$ or $2n+1, 2n+3, 2n+5$) allow ft for this M1 only	allow $n^2 - (n+2)^2$ for M1 then A0 for negative answer; may still earn last B1
			$4n + 4$ obtained with at least one interim step shown	A1		
			$4(n + 1)$ or $\frac{4n+4}{4} = n+1$	B1 **[4]**	may be obtained independently	B0 for $n+1 \times 4$
10	**(i)**		$AB^2 = 5^2 + 5^2 = 50$	B1	oe with AB; may go straight from correct unsimplified form to 50 with no interim working (applies to both marks), but for 2 marks any interim working must be correct	for 2 marks to be awarded, notation used must be fully correct. Penalise only one mark if squares and square roots eg 50 and $\sqrt{50}$ confused, or brackets used incorrectly or AB and BC missing, etc, but working is otherwise correct
			$BC^2 = 7^2 + 1^2 = 50$	B1 **[2]**	oe with BC	

10	**(ii)**		grad AC = $\frac{-1-3}{5-3}\left[=-2\right]$ oe isw grad perp = ½ or ft from their grad AC or finding gradient of their BF $y+2=their\,\frac{1}{2}(x+2)$ or $-2=their\,\frac{1}{2}(-2)+c$ oe $y=\frac{1}{2}x-1$ isw	B1 M1 M1 A1 **[4]**	or midpt F of AC = $\left(\frac{5+3}{2},\frac{3-1}{2}\right)$ may be seen in eqn of perp or using coords of their F; no ft for using their grad AC for this allow both M1s for eqn of line through B and their F	must be a changed gradient related to grad AC, or be their grad BF, to score this M1
10	**(iii)**		(10, 4)	2 **[2]**	**B1** for each coordinate or **M1** for use of $\overrightarrow{AD}=\overrightarrow{BC}$, $\overrightarrow{CD}=\overrightarrow{BA}$ or $\overrightarrow{BF}=\overrightarrow{FD}$ or for correct method for intersection of (ii) line and line through A parallel to BC [$y=3+\frac{1}{7}(x-3)$ oe or $y=\frac{1}{7}x+\frac{18}{7}$ oe if correct] or line through C parallel to BA [$y = x - 6$ if correct] allow **SC1** for (-4 , 2) for ADBC found, or (0 , -6) for ABDC found [both parallelograms, not rhombi]	NB more complicated methods exist using simultaneous equations and eg grad BD = ½ and $AD^2 = BC^2$

10	**(iv)**		grad AD = $\frac{4-3}{10-3}$ or $\frac{1}{7}$ or ft relevant D from attempt at ABCD	M1	however, if D = (0, −6), or (−4, 2) or other attempt at ABDC or ADBC in (iii), or other attempt where one or both coords of D are less than the corresponding coords of (8, 3.8) award only **SC1** in (iv) for showing by diagram or coordinates that E is obviously outside the rhombus ABDC eg since its *x*-coordinate is greater than the *x*-coordinate of all the vertices (or similarly *y*-coordinates)	some are working with CD only, not AD. Give M0 but allow SC1 for showing that CD is $y = x - 6$ and then finding on CD when $y = 3.8$, $x = 9.8$ or when $x = 8$, $y = 2$; allow ft from wrong but relevant D – see 'however' in previous column
			so when $x = 8$, y-coord. on AD = $3+\frac{1}{7}\times(8-3)$ or ft	M1	or use of $y-3=\frac{1}{7}(8-3)$ oe or **M1** for $3.8-3=\frac{1}{7}(x-3)$ oe, after correct method for finding eqn of AD using coords of A and D – need not be simplified [AD is $y=3+\frac{1}{7}(x-3)$ oe or $y=\frac{1}{7}x+\frac{18}{7}$ oe if correct]	may use coords of their D not A in eqn i.e. M1 for substituting one coord of E in their equation for AD after correct method seen for AD, or AD correct; condone substituting both coords of E
			= $3\frac{5}{7}$ or 3.7…	A1	or on AD when $y = 3.8$, $x = 8.6$ no ft from wrong D	
			conclusion E is outside rhombus, with $3\frac{5}{7}$ shown to be less than 3.8 if not seen earlier, if y used	A1	no ft from wrong D	
			or	**or**		

			grad AD = $\frac{4-3}{10-3}\left[=\frac{1}{7}\right]$ or ft their D	M1		similarly may find line through E parallel to AD (M1 for gradient of AD as in first method and M1 for eqn $y=\frac{1}{7}x+(3.8-\frac{8}{7})$ oe and compare with eqn of AD $y=3+\frac{1}{7}(x-3)$ oe: A1 for showing $3.8-\frac{8}{7}>\frac{18}{7}$, A1 for conclusion E is outside rhombus
			grad AE = $\frac{0.8}{5}$ [=0.16]	M1	or allow M1, for DE used, dep on first M1, for grad DE = $\frac{0.2}{2}[=0.1]$, no ft from wrong D	the SC for working with CD rather than AD is also available if they use gradients – allow SC1 if they find grad CD = 1, and grad CE = 4.8/3 or 1.6 or grad DE $\frac{0.2}{2}[=0.1]$
			grad. AE shown to be greater than grad AD eg 0.16 > 0.14… or grad DE shown to be less than grad AD eg 0.1 < 0.014…	A1	no ft from wrong D;	
			conclusion E is outside rhombus	A1 **[4]**	no ft from wrong D	

11	**(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 –5, 1.5 and 2	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

11	**(ii)**		roots of g(x) = 0 are -8, -1.5, -1	M1	or [g(x) =] (x + 1)(2x + 3)(x + 8) oe, condoning error in one bracket	NB examiners must use annotation in this part; a tick where each mark is earned is sufficient
			correct expansion of two of their two-term factors	M1	dep on attempt on f($x \pm 3$) attempted; may be 3 or 4 terms	condone lack of brackets if correct expansions as if they were there [for reference re ft: if correct, f(x – 3) = (x + 2)(2x – 9)(x – 5); allow ft if two of these brackets correct]
			correct expansion and completion to given answer, $2x^3 + 21x^2 + 43x + 24$	A1	must be working for this step before given answer backwards working: allow M1 for obtaining a correct linear × a quadratic factor of given g(x) and M1 for obtaining all 3 linear factors and A1 for justifying that these are the correct factors from using the translated roots	or for direct expansion of all three correct factors, allow M1 for $2x^3 + 16x^2 + 2x^2 + 3x^2 + 24x + 16x + 3x + 30$, condoning an error in one term, and A1 if no error for completion by then stating given answer
		or		**or**		
			finding f(x) = $2x^3 + 3x^2 - 29x + 30$ and substituting (x + 3) or (x – 3) for x	M1	condoning one error; condone omission of 'f(x) =' or 'y = '	f(x) may appear in (i) but no credit unless result is used in (ii)
			correct expansion for $(x + 3)^3$ and $(x + 3)^2$	M1		
			correct expansion and completion to given answer, $2x^3 + 21x^2 + 43x + 24$	A1 **[3]**		

11	**(iii)**		$-16 + 84 - 86 + 24 = 6$ or $-16 + 84 - 86 + 24 - 6 = 0$	B1	or **B1** for the correct division of $g(x) - 6$ by $(x + 2)$ or for the quadratic factor found by inspection, and, for either of these, the conclusion that no remainder means that $g(-2) = 6$ oe or **B1** for correct division of $g(x)$ by $(x + 2)$ with remainder 6 and the conclusion that $g(-2) = 6$ oe	NB examiners must use annotation in this part; a tick where each mark is earned is sufficient
			need roots of] $2x^3 + 21x^2 + 43x + 18 = 0$ soi	B1	or clear working with $g(x)$ and remainder of 6 found when divided by $(x + 2)$ or $g(x) = (x + 2)(2x^2 + 17x + 9) + 6$ clearly stated at some point	
			attempt at division by $(x + 2)$ as far as $2x^3 + 4x^2$ in working	M1	or inspection with at least two terms of three–term quadratic factor correct;	allow working with $g(x) = 0$ for this M1
			correctly obtaining $2x^2 + 17x + 9$	A1	if working with $g(x) = 0$ must show remainder of 6 eg in working	
			$\frac{-17 \pm \sqrt{17^2 - 4 \times 2 \times 9}}{2 \times 2}$	M1	condone one error in quadratic formula or completing square; **M0** for incorrect quadratic 'factor'	
			$\frac{-17 \pm \sqrt{217}}{4}$ oe isw	A1 **[6]**		

12	**(i)**		$\left(x+\frac{1}{2}\right)^2+2\frac{3}{4}$ oe	3	**B1** for $m = ½$ oe **B2** for $p=2\frac{3}{4}$ oe or **M1** for $3 -$ their m^2	Ignore '=0' M0 if $m = 0$
			min $y = 2\frac{3}{4}$ oe or ft, isw or showing that if $y = 0$, their $\left(x+\frac{1}{2}\right)^2$ is negative, so no real roots [or no solution]	B1 **[4]**	ft their p, provided $p > 0$; ignore x value of min pt stated, even if wrong ft **B0** if only say tp rather than min, though need not justify min	B0 if explanation not 'hence' eg using $b^2 - 4ac$ on $x^2 + x + 3 = 0$ condone B1 for min pt = $2\frac{3}{4}$
12	**(ii)**		$x^2-4x-12[=0]$	M1	condone one error; for equating and simplifying to solvable form	rearranging to zero not required if they go on to complete the square
			$(x-6)(x+2)[=0]$	M1	for factors giving at least two terms correct, ft, or for subst in formula with at most one error ft	similarly for attempt at completing square
			$x = 6$ or -2	A1	allow **A1** for coords with x values 6 and -2 but wrong y values	
			$y = 45$ or 5	A1 **[4]**	or **A1** each for (6, 45) and $(-2, 5)$	

12	**(iii)**		$x^2 - 4x - (9+k)[=0]$	M1	condone one error, but must include k **M0** if not all on one side of equation, unless completing the square	Eg allow M1 for $y = x^2 - 4x - (9+k)$ or for $x^2 - 4x(-9-k)[=0]$ for completing the square method: eg $(x-2)^2 - 4 = 9 + k$ earns M1 and the second A1, which is likely to be earned before the first A1
			$b^2 - 4ac < 0$ oe soi	A1	may be earned near end with correct inequality sign used there	allow '$b^2 - 4ac$ is negative' oe; 0 for just 'discriminant < 0' unless implied by later work; A0 for $\sqrt{b^2 - 4ac} < 0$; for completing the square, allow A1 for $4 + 9 + k < 0$ oe
			$16 + 4 \times (9 + k)$ (< 0) oe or ft	A1	for correct substitution ft into $b^2 - 4ac$; brackets / signs must be correct; allow recovery from eg wrong bracket earlier but **A0** if recovery line contains additional error(s)	can be earned with equality or wrong inequality, or in formula (ignore rest of formula); for completing the square method, will see $4 + 9 + k$ oe, or on opposite sides of an inequality/ equation eg $9 + k < -4$ M0 for trials of values of k in $b^2 - 4ac$
			$k < -13$ www	A1 **[4]**	**A0** for just $k < -52/4$	

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4751 Introduction to Advanced Mathematics (C1)

General Comments:

In general candidates were confidently applying the basic techniques required, with many candidates gaining most of the marks available in section A.

All questions were found to be accessible, with candidates rarely omitting to answer a question or part question.

It is pleasing to note that there were fewer errors in arithmetic this year, but as usual, questions involving fractions (such as question 4) saw more than occasional errors, whilst manipulating surds (such as in question 7) was another topic where candidates failed to gain all the available marks. Examiners were surprised how many candidates struggled to simplify correctly the numerical values in question 2(ii).

Comments on Individual Questions:

Section A

Question No. 1
Most candidates coped well with this question, usually scoring full marks. Errors included drawing a line with the wrong gradient, ie +2 or - 1/2 and marks were also dropped due to inaccurately drawn lines based upon plotting one point and roughly estimating where a gradient of -2 would be. It would have been much more accurate for those candidates to plot at least two points when drawing a straight line. If plotting points it would be wise for candidates to only mark a small point, not a large circular blob encompassing a complete square as some candidates did. It was sad to see some candidates not using a ruler and therefore drawing wobbly freehand lines.

Question No. 2
Not many candidates dropped marks in the first part. Those who did usually lost out due to their inability to convert a mixed number into an improper fraction, preventing them from scoring any of the marks. Candidates scoring 0 often seemed to have little idea with indices, but these were a minority. Some candidates reached $\frac{1}{\left(1\frac{7}{9}\right)^{\frac{1}{2}}}$, gaining a mark for this, but then did not know how to proceed with their triple-decker fraction. In the second part, the vast majority of candidates coped well, the main mistakes were usually due to the misapplication of the rules of indices, adding when the powers should be multiplied. What was concerning was the minority of candidates who could not multiply or divide the numerical values forming the coefficient.

Question No. 3
This was a straight-forward inequality with very few mistakes made. The most common mistake seen involved mistakenly multiplying out the bracket to give $5x-3$ rather than $5x-15$. Generally, candidates worked very well with the inequality sign in this question and most, if the need arose, remembered to change the sign of the inequality when dividing or multiplying by a negative value.

Question No. 4
Candidates coped very well with equation and fraction manipulation. Both method marks were nearly always earned. A variety of methods were used with the substitution of $x=2y+4$ into the first equation being the most common. Some multiplied both equations, in order to be able to use elimination. Where the second equation was multiplied by 2 there were some errors in subtracting the equations. Rearranging both equations to get $x=...$ or $y=...$ and then equating the results was

also fairly common and, even though this resulted in fractions, was usually successful. However, handling the signs when rearranging the second equation was a source of error. A minority of candidates stopped after finding one of the values (usually *y*) and failed to find the coordinates, as requested in the question. It should be noted that very few candidates checked their answers and it is advisable to do so in questions of this nature.

Question No. 5
There were a small number of candidates who incorrectly worked out the centre of the circle, usually giving the centre with incorrect signs. A number of candidates gave the radius as either 5 or 25 but most candidates scored full marks here. The vast majority of candidates found the correct equation of the required line, with those who dropped marks usually because they chose 5 as the gradient and not -5. Some of these candidates clearly misunderstood the concept of $y = mx + c$ as they clearly believed that the coefficient of *x* was the gradient no matter what side of the equation the *x* term appeared on. Only a small minority used a gradient based on the negative reciprocal.

Question No. 6
There were many candidates who found the new subject both efficiently and accurately. It was rare to find a candidate who didn't know to square both sides straight away but there were a very small minority who went off the rails at that point, not coping with the *a* + *b* as a denominator. A small minority of candidates solved for *a* instead of *b*. There were a handful of candidates who insisted on using a diagonal fraction line instead of a horizontal one and this lead to algebraic missteps when manipulating the algebra. A common error was to take the correct answer of $b = \frac{V - r^2 a}{r^2}$ and cancel this incorrectly to $b = V - a.$.

Question No. 7
In the first part, the vast majority of candidates understood the need to multiply the numerator and denominator by $\left(3 - \sqrt{7}\right)$, however a few tried to multiply both parts of the fraction by $\sqrt{7}$, or by $\left(3 + \sqrt{7}\right)$, or to 'cancel' the $\sqrt{7}$ in the numerator and denominator. The most common error was in determining $-2\sqrt{7} \times \sqrt{7}$ which commonly retained a multiple of $\sqrt{7}$. In the second part, most candidates could simplify $\sqrt{98}$ to $7\sqrt{2}$ (so scoring at least one mark) but many had difficulties with $\frac{12}{\sqrt{2}}$ with some multiplying the $\sqrt{2}$ by the $\sqrt{98}$ or leaving their answer as $\frac{26}{\sqrt{2}}$.

Question No. 8
This problem-solving binomial expansion question discriminated extremely well. Some candidates misunderstood the concept of the constant term being 32 and this was then applied incorrectly in a variety of ways, either being assigned to the value of *a* or to ${}^5C_3$. Another common error was to work with the term bx^3 rather than $(bx)^3$ sometimes leading to an answer $b = 27$ or -27. Having *x*'s on only one side of an equation and then ignoring them until the last statement was also common, as was a correct $b^3 = -27$ followed by the loss of the negative sign, leading to $b = 3$. Candidates' trialling factors of -108 (with no consideration of the 32) often reached correct values for a and b but were not awarded full marks since this went against the rubric on the front cover which requires that candidates show sufficient detail of the working to indicate that a correct method has been used. However even the poorest candidates usually gained a mark for identifying the binomial coefficient 10.

Question No. 9
The majority of candidates that attempted this standard proof question gained full marks, showing the needed interim step(s) to obtain the corresponding accuracy marks. A minority chose wrong expressions for the three integers (e.g. *n*, 2*n*, 3*n*). Unfortunately candidates missing the middle term of 4*n* when squaring the (*n* + 2) term was seen quite often. Some candidates considered the

first term squared minus the last term squared and then conveniently ignored the negative signs. A handful of candidates attempted an entirely numerical approach.

Section B

Question No. 10
(i) Many obtained two marks here without any difficulty. Candidates who used less formal notation often lost marks due to missing brackets or confusion about whether they were working with AB or AB^2. A few candidates confused lengths and gradients.

(ii) This was completed well by the majority of candidates. A few quoted the gradient formula incorrectly or had difficulty simplifying the gradient accurately, but were then able to find the associated perpendicular gradient and use the equation of a straight line well.

(iii) This presented a challenge to a significant number of candidates, with those who chose not to use a vector related method often getting bogged down with complicated algebra. A common error was to not appreciate the importance of the letter order ABCD, and instead give ACDB or ACBD, which earned partial credit but affected the difficulty of part (iv), so limiting the marks available there.

(iv) This part required candidates to apply some reason and insight rather than just applying well-drilled techniques. Candidates would have found it helpful to sketch a diagram with their D marked, to ensure that they were comparing E to the correct line (AD). Most started by finding the equation of AD and a good number successfully used this to decide whether E was above or below AD. Some who substituted x = 8 into AD found y = $3\frac{5}{7}$ but did not prove that this is less than 3.8. Some compared with CD rather than AD. Some candidates used other methods, often efficiently, such as showing that the gradient of AE was greater than the gradient of AD.

Question No. 11
(i) This was completed accurately with many candidates able to sketch the graph with little preliminary working. The common errors were having a curve which stopped at the *x*-axis at one or both ends, or a curve which flicked out at an end towards a turning point, or either not marking the *y* intercept or calling it 15. A few candidates obtained *y*-intercepts of -30, or *x*-intercepts with incorrect signs/values. In a few cases this led to a negative cubic rather than a positive cubic. Very few failed to gain any marks. Some curves were a poor shape because candidates tried to make the scales on both axes the same.

(ii) Some candidates weren't sure which way to go so attempted pages of different combinations of brackets. Most who did know what to do got the full marks. Those who put (x+3) into the expanded f(x) gave themselves more long-winded expansions to do but most got there.

(iii) Where candidates set out a well-organised solution, they were able to progress directly to the fully factorised expression (with g(x) = 6 rather than 0 providing extra challenge). The majority were able to find the correct quadratic factor following division by (x + 2), with a few using synthetic division and a sizeable minority finding the solution by inspection. At this stage most then found the correct final solution, although some had difficulty squaring 17, and a few stopped at attempts to factorise. Most earned the mark for showing that g(-2) = 6 by substituting $x = -2$ into the equation; those who relied on their division by (x + 2) often failed to say what this showed.

Question No. 12
(i) Most completed the square correctly. Some candidates did not take notice of the 'hence' in the question and used the discriminant, which did not gain the final mark.

(ii) Finding the coordinates of the points of intersection of the two curves was done well. A few forgot to work out both coordinates, and some, having found x to be 6 or -2, put (6, 0) and (-2, 0).

(iii) This question posed problems for some candidates who were unsure of an appropriate strategy. However, a good number of the candidates found the set of values of k successfully. A significant minority, while knowing that they needed to use the discriminant, made arithmetical and/or algebraic errors, often caused by poor use of brackets. Few used the completing the square method.

Unit level raw mark and UMS grade boundaries June 2017 series

For more information about results and grade calculations, see www.ocr.org.uk/ocr-for/learners-and-parents/getting-your-results

AS GCE / Advanced GCE / AS GCE Double Award / Advanced GCE Double Award

GCE Mathematics (MEI)

				Max Mark	a	b	c	d	e	u
4751	01	C1 – MEI Introduction to advanced mathematics (AS)	Raw	72	63	58	53	49	45	0
			UMS	100	80	70	60	50	40	0
4752	01	C2 – MEI Concepts for advanced mathematics (AS)	Raw	72	55	49	44	39	34	0
			UMS	100	80	70	60	50	40	0
4753	01	(C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	54	49	45	41	36	0
4753	02	(C3) MEI Methods for Advanced Mathematics with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4753	82	(C3) MEI Methods for Advanced Mathematics with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
			UMS	100	80	70	60	50	40	0
4754	01	C4 – MEI Applications of advanced mathematics (A2)	Raw	90	67	61	55	49	43	0
			UMS	100	80	70	60	50	40	0
4755	01	FP1 – MEI Further concepts for advanced mathematics (AS)	Raw	72	57	52	47	42	38	0
			UMS	100	80	70	60	50	40	0
4756	01	FP2 – MEI Further methods for advanced mathematics (A2)	Raw	72	65	58	52	46	40	0
			UMS	100	80	70	60	50	40	0
4757	01	FP3 – MEI Further applications of advanced mathematics (A2)	Raw	72	64	56	48	41	34	0
			UMS	100	80	70	60	50	40	0
4758	01	(DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	63	56	50	44	37	0
4758	02	(DE) MEI Differential Equations with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4758	82	(DE) MEI Differential Equations with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
			UMS	100	80	70	60	50	40	0
4761	01	M1 – MEI Mechanics 1 (AS)	Raw	72	57	49	41	34	27	0
			UMS	100	80	70	60	50	40	0
4762	01	M2 – MEI Mechanics 2 (A2)	Raw	72	56	48	41	34	27	0
			UMS	100	80	70	60	50	40	0
4763	01	M3 – MEI Mechanics 3 (A2)	Raw	72	58	50	43	36	29	0
			UMS	100	80	70	60	50	40	0
4764	01	M4 – MEI Mechanics 4 (A2)	Raw	72	53	45	38	31	24	0
			UMS	100	80	70	60	50	40	0
4766	01	S1 – MEI Statistics 1 (AS)	Raw	72	61	55	49	43	37	0
			UMS	100	80	70	60	50	40	0
4767	01	S2 – MEI Statistics 2 (A2)	Raw	72	56	50	45	40	35	0
			UMS	100	80	70	60	50	40	0
4768	01	S3 – MEI Statistics 3 (A2)	Raw	72	63	57	51	46	41	0
			UMS	100	80	70	60	50	40	0
4769	01	S4 – MEI Statistics 4 (A2)	Raw	72	56	49	42	35	28	0
			UMS	100	80	70	60	50	40	0
4771	01	D1 – MEI Decision mathematics 1 (AS)	Raw	72	52	46	41	36	31	0
			UMS	100	80	70	60	50	40	0
4772	01	D2 – MEI Decision mathematics 2 (A2)	Raw	72	53	48	43	39	35	0
			UMS	100	80	70	60	50	40	0
4773	01	DC – MEI Decision mathematics computation (A2)	Raw	72	46	40	34	29	24	0
			UMS	100	80	70	60	50	40	0
4776	01	(NM) MEI Numerical Methods with Coursework: Written Paper	Raw	72	58	53	48	43	37	0
4776	02	(NM) MEI Numerical Methods with Coursework: Coursework	Raw	18	14	12	10	8	7	0
4776	82	(NM) MEI Numerical Methods with Coursework: Carried Forward Coursework Mark	Raw	18	14	12	10	8	7	0
			UMS	100	80	70	60	50	40	0
4777	01	NC – MEI Numerical computation (A2)	Raw	72	55	48	41	34	27	0

		UMS	100	80	70	60	50	40	0
4798	01 FPT - Further pure mathematics with technology (A2)	Raw	72	57	49	41	33	26	0
		UMS	100	80	70	60	50	40	0

GCE Statistics (MEI)

			Max Mark	a	b	c	d	e	u
G241	01 Statistics 1 MEI (Z1)	Raw	72	61	55	49	43	37	0
		UMS	100	80	70	60	50	40	0
G242	01 Statistics 2 MEI (Z2)	Raw	72	55	48	41	34	27	0
		UMS	100	80	70	60	50	40	0
G243	01 Statistics 3 MEI (Z3)	Raw	72	56	48	41	34	27	0
		UMS	100	80	70	60	50	40	0

GCE Quantitative Methods (MEI)

			Max Mark	a	b	c	d	e	u
G244	01 Introduction to Quantitative Methods MEI	Raw	72	58	50	43	36	28	0
G244	02 Introduction to Quantitative Methods MEI	Raw	18	14	12	10	8	7	0
		UMS	100	80	70	60	50	40	0
G245	01 Statistics 1 MEI	Raw	72	61	55	49	43	37	0
		UMS	100	80	70	60	50	40	0
G246	01 Decision 1 MEI	Raw	72	52	46	41	36	31	0
		UMS	100	80	70	60	50	40	0

Level 3 Certificate and FSMQ raw mark grade boundaries June 2017 series

For more information about results and grade calculations, see www.ocr.org.uk/ocr-for/learners-and-parents/getting-your-results

Level 3 Certificate Mathematics for Engineering

			Max Mark	a*	a	b	c	d	e	u
H860	01	Mathematics for Engineering	This unit has no entries in June 2017							
H860	02	Mathematics for Engineering								

Level 3 Certificate Mathematical Techniques and Applications for Engineers

				Max Mark	a*	a	b	c	d	e	u
H865	01	Component 1	Raw	60	48	42	36	30	24	18	0

Level 3 Certificate Mathematics - Quantitative Reasoning (MEI) (GQ Reform)

				Max Mark	a	b	c	d	e	u
H866	01	Introduction to quantitative reasoning	Raw	72	54	47	40	34	28	0
H866	02	Critical maths	Raw	60*	48	42	36	30	24	0
		*Component 02 is weighted to give marks out of 72	Overall	144	112	97	83	70	57	0

Level 3 Certificate Mathematics - Quantitive Problem Solving (MEI) (GQ Reform)

				Max Mark	a	b	c	d	e	u
H867	01	Introduction to quantitative reasoning	Raw	72	54	47	40	34	28	0
H867	02	Statistical problem solving	Raw	60*	41	36	31	27	23	0
		*Component 02 is weighted to give marks out of 72	Overall	144	103	90	77	66	56	0

Advanced Free Standing Mathematics Qualification (FSMQ)

				Max Mark	a	b	c	d	e	u
6993	01	Additional Mathematics	Raw	100	72	63	55	47	39	0

Intermediate Free Standing Mathematics Qualification (FSMQ)

				Max Mark	a	b	c	d	e	u
6989	01	Foundations of Advanced Mathematics (MEI)	Raw	40	35	30	25	20	16	0