OCR
Oxford Cambridge and RSA

Wednesday 18 May 2016 – Morning

AS GCE MATHEMATICS (MEI)

4751/01 Introduction to Advanced Mathematics (C1)

QUESTION PAPER

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**. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- 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 bar codes.
- 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.

No calculator can be used for this paper

Section A (36 marks)

1 Find the value of each of the following.

(i) 3^0 **[1]**

(ii) $9^{\frac{3}{2}}$ **[2]**

(iii) $\left(\frac{4}{5}\right)^{-2}$ **[2]**

2 Find the coordinates of the point of intersection of the lines $2x + 3y = 12$ and $y = 7 - 3x$. **[4]**

3 **(i)** Solve the inequality $\frac{1-2x}{4} > 3$. **[2]**

(ii) Simplify $(5c^2d)^3 \times \frac{2c^4}{d^5}$. **[2]**

4 You are given that $a = \frac{3c+2a}{2c-5}$. Express a in terms of c. **[4]**

5 **(i)** Express $\sqrt{50} + 3\sqrt{8}$ in the form $a\sqrt{b}$, where a and b are integers and b is as small as possible. **[2]**

(ii) Express $\frac{5+2\sqrt{3}}{4-\sqrt{3}}$ in the form $c + d\sqrt{3}$, where c and d are integers. **[3]**

6 Find the binomial expansion of $(1 - 5x)^4$, expressing the terms as simply as possible. **[4]**

7 **(i)** Solve the equation $(x - 2)^2 = 9$. **[2]**

(ii) Sketch the curve $y = (x - 2)^2 - 9$, showing the coordinates of its intersections with the axes and its turning point. **[3]**

8 You are given that $f(x) = x^3 + ax + c$ and that $f(2) = 11$. The remainder when $f(x)$ is divided by $(x + 1)$ is 8. Find the values of a and c. **[5]**

Section B (36 marks)

9 Fig. 9 shows the curves $y = \frac{1}{x+2}$ and $y = x^2 + 7x + 7$.

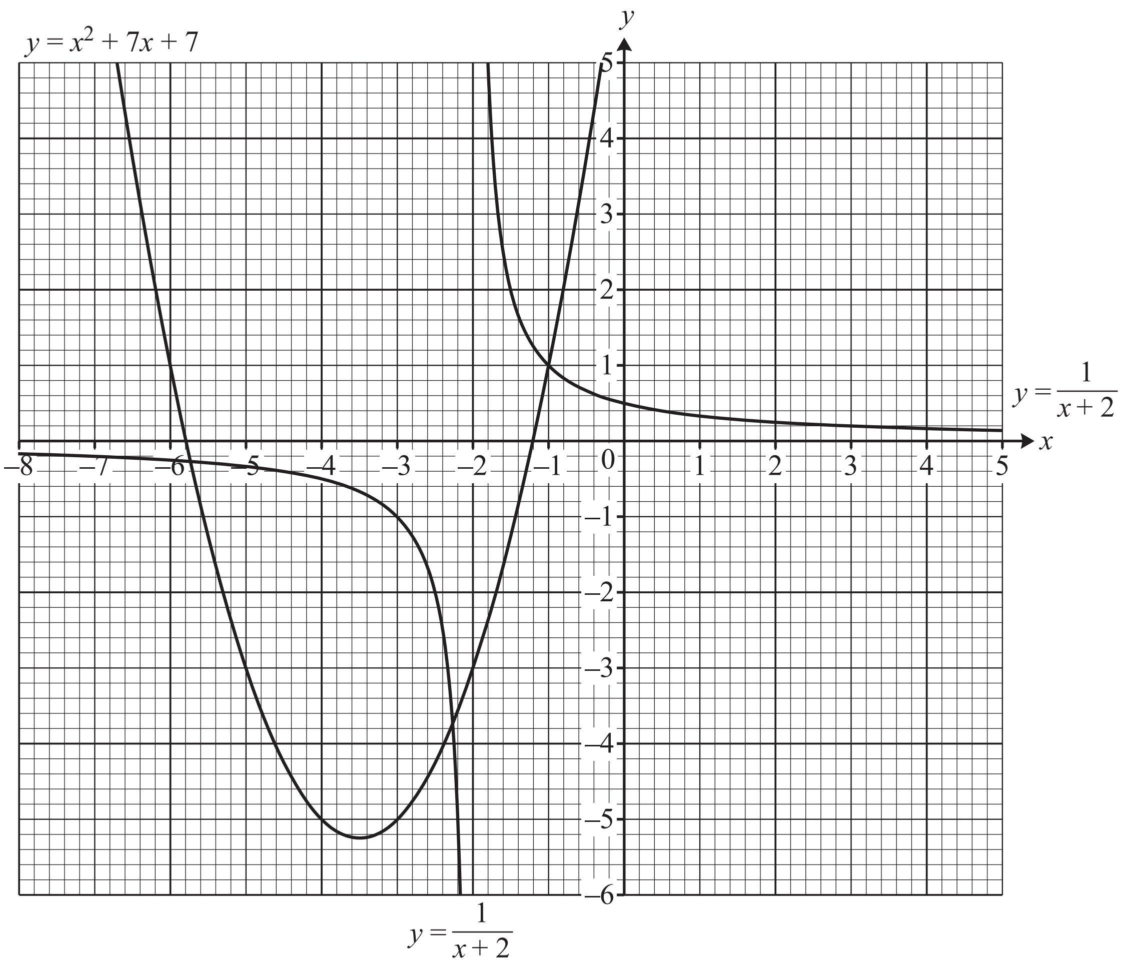

Fig. 9

(i) Use Fig. 9 to estimate graphically the roots of the equation $\frac{1}{x+2} = x^2 + 7x + 7$. **[2]**

(ii) Show that the equation in part **(i)** may be simplified to $x^3 + 9x^2 + 21x + 13 = 0$. Find algebraically the exact roots of this equation. **[7]**

(iii) The curve $y = x^2 + 7x + 7$ is translated by $\begin{pmatrix} 3 \\ 0 \end{pmatrix}$.

(*A*) Show graphically that the translated curve intersects the curve $y = \frac{1}{x+2}$ at only one point. Estimate the coordinates of this point. **[2]**

(*B*) Find the equation of the translated curve, simplifying your answer. **[2]**

10 Fig. 10 shows a sketch of the points A (2, 7), B (0, 3) and C (8, −1).

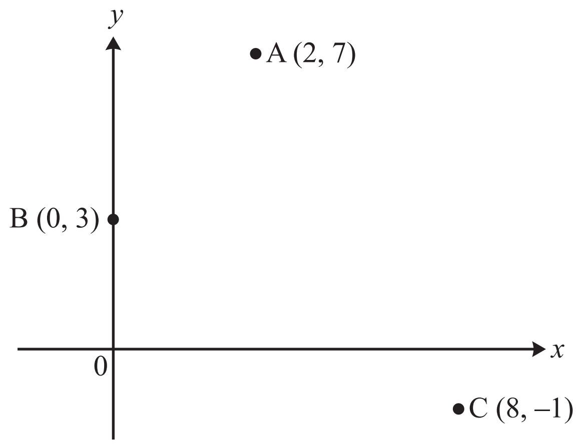

Fig. 10

(i) Prove that angle ABC is 90°. **[3]**

(ii) Find the equation of the circle which has AC as a diameter. **[4]**

(iii) Find the equation of the tangent to this circle at A. Give your answer in the form $ay = bx + c$, where a, b and c are integers. **[4]**

11 **(i)** Find the coordinates of the points of intersection of the curve $y = 2x^2 - 5x - 3$ with the axes. **[3]**

(ii) Find the coordinates of the points of intersection of the curve $y = 2x^2 - 5x - 3$ and the line $y = x + 3$. **[4]**

(iii) Find the set of values of k for which the line $y = x + k$ does not intersect the curve $y = 2x^2 - 5x - 3$. **[5]**

END OF QUESTION PAPER

OCR
Oxford Cambridge and RSA

Wednesday 18 May 2016 – Morning

AS GCE MATHEMATICS (MEI)

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:
None

Duration: 1 hour 30 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

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.** Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- 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 bar codes.
- 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.

No calculator can be used for this paper

Section A (36 marks)

1 (i)	
1 (ii)	
1 (iii)	
2	

3 (i)	
3 (ii)	
4	

5 (i)	
5 (ii)	
6	

7 (i)	
7 (ii)	

8

Section B (36 marks)

9 (i)	
9 (ii)	

9 (iii) (*A*)

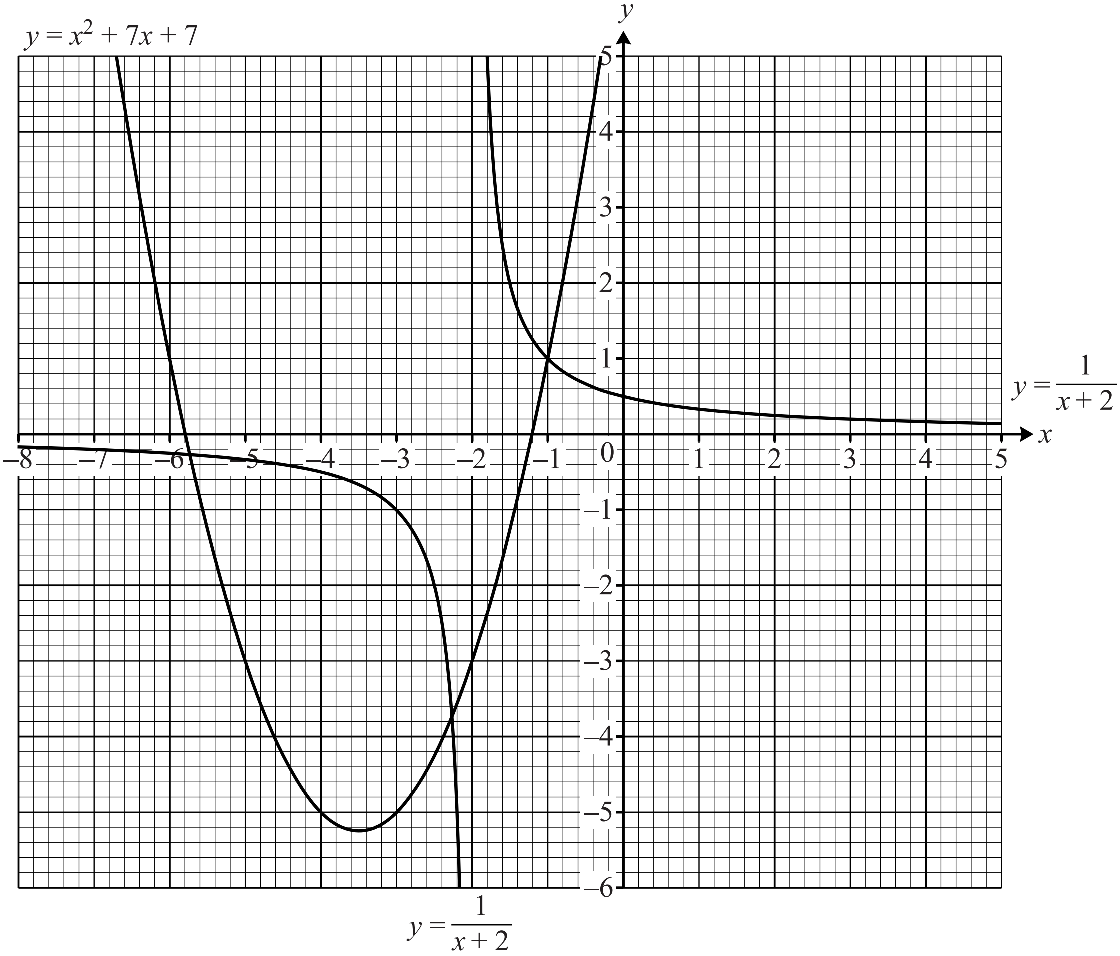

Fig. 9

9 (iii) (*B*)

10 (i)	
10 (ii)	

10 (iii)	

11 (i)	
11 (ii)	

11 (iii)	

OCR
Oxford Cambridge and RSA

OCR
Oxford Cambridge and RSA

GCE

Mathematics (MEI)

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

Advanced Subsidiary GCE

Mark Scheme for June 2016

1. These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

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

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)**		1	1 **[1]**		
1	**(ii)**		27	2 **[2]**	condone ± 27; **B1** for $[\pm]3^3$ or $\sqrt{729}$ or for $\left[9^{\frac{1}{2}} =\right] 3$ or ± 3 soi	
1	**(iii)**		$\frac{25}{16}$ or $1\frac{9}{16}$ isw	2 **[2]**	**B1** for $\frac{5}{4}$ or $\frac{1}{\frac{16}{25}}$ or $\frac{16}{25}$ oe	B0 for 1.5625 without fractions seen; if this is found, check for possible use of calculator throughout the paper
2			substitution to eliminate one variable	M1	or multiplication or division to make one pair of coefficients the same; condone one error in either method	
			simplification to $ax = b$ or $ax - b = 0$ form, or equivalent for y	M1	or appropriate subtraction / addition; condone one further error in either method	independent of first M1
			(9/7, 22/7) oe or $x = 9/7$ $y = 22/7$ oe isw	A2 **[4]**	**A1** each	A0 for just rounded decimals or for $-9/-7$ oe
3	**(i)**		$x < -11/2$ oe www as final answer	2 **[2]**	**M1** for $-2x > 11$ oe or $x < 11/-2$	if working with equals throughout, give 2 for correct final answer, 0 otherwise

Question			Answer	Marks	Guidance	
3	(ii)		$250c^{10}d^{-2}$ or $\frac{250c^{10}}{d^2}$ as final answer	2 **[2]**	**B1** for two correct elements; must be multiplied if B0, allow **SC1** for $125c^6d^3$ obtained from numerator or for all elements correct but added	
4			$a(2c-5) = 3c + 2a$ or $2ac - 5a = 3c + 2a$	M1	for multiplying up correctly (may also expand brackets)	annotate this question if partially correct
			$a(2c-5) - 2a = 3c$ or $2ac - 7a = 3c$ or ft	M1	for collecting a terms on one side, remaining term[s] on other [need not be simplified]	ft only if two or more a terms
			$a(2c-7) = 3c$ or ft	M1	for factorising a terms, need not be simplified; may be implied by final answer	ft only if two or more a terms, needing factorising may be earned before 2nd M1
			$[a=]\frac{3c}{2c-7}$ or simplified equivalent or ft as final answer	M1 **[4]**	for division by their two-term factor (accept a 3 term factor that would simplify to 2 terms); for all 4 marks to be earned, work must be fully correct and simplified and not have a triple-or quadruple-decker answer	candidates whose final answer expresses c in terms of a: treat as MR after the first common M and mark equivalently, applying MR−1 if they gain further Ms. So that a final answer, correctly obtained, of $[c=]\frac{7a}{2a-3}$ or simplified equivalent earns 3 marks in total
5	(i)		$11\sqrt{2}$	2 **[2]**	**M1** for $\left[\sqrt{50}=\right]5\sqrt{2}$ or $\left[3\sqrt{8}=\right]6\sqrt{2}$	

Question			Answer	Marks	Guidance	
5	**(ii)**		attempting to multiply numerator and denominator of fraction by $4+\sqrt{3}$	M1		
			$2+\sqrt{3}$ or $2+1\sqrt{3}$ or $c = 2$ and $d = 1$	A2	or **B1** for denominator = 13 soi or numerator = $26+13\sqrt{3}$ soi	
			or cross-multiplying by $4-\sqrt{3}$ and forming a pair of simultaneous equations in c and d, with at most one error	M1		
			$c = 2$ and $d = 1$	A2 **[3]**	**A1** for one correct	

Question			Answer	Marks	Guidance	
6			$1 - 20x + 150x^2 - 500x^3 + 625x^4$ as final answer	4 **[4]**	part marks can be awarded for earlier stages if final answer incorrect or not fully simplified: **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 (condone eg $+(-20x)$ or $+-20x$ instead of $-20x$) **M2** for 3 terms correct or for correct expansion seen without correct evaluation of coefficients [if brackets missing in elements such as $(-5x)^2$ there must be evidence from calculation that $25x^2$ has been used] binomial coefficients such as ${}^4C_2$ are not sufficient – must show understanding of these symbols by at least partial evaluation; or **M1** for 1 4 6 4 1 soi, eg in Pascal's triangle or in expansion where powers of 5 have been ignored	for binomial coefficients, ${}^4C_2$ or factorial notation is not sufficient but accept $\frac{4\times3\times2\times1}{2\times1\times2\times1}$ oe etc 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

Question			Answer	Marks	Guidance	
7	(i)		[x =] 5, [x =] –1 www	2 **[2]**	**M1** for $x – 2 = \pm 3$ or for $(x – 5)(x + 1)$ [=0]	0 for just $x = 5$ or for $x – 2 = 3$
7	(ii)		parabola shape curve the correct way up	1	must extend beyond x-axis;	condone 'U' shape or very slight curving back in/out; condone some doubling / feathering – deleted work sometimes still shows up in rm assessor; must not be ruled; condone fairly straight with clear attempt at curve at minimum; be reasonably generous on attempt at symmetry e.g. condone minimum on y-axis for this mark
			intersecting x-axis at 5 and –1 or ft from (i) and y-axis at –5	1		
			turning point (2, −9)	1 **[3]**	seen on graph or identified as tp elsewhere in this part	may be implied by 2 and −9 marked on axes 'opposite' turning point
8			$8 + 2a + c = 11$	B1	accept 2^3 instead of 8	
			$–1 – a + c = 8$	B1	or $c – (a + 1) = 8$ oe (often from division) accept $(–1)^3$ instead of –1	
			Correct method for eliminating one variable, condoning one further error	M1	dep on two equations in a and c and at least B1 earned	
			$a = –2$, $c = 7$	A2 **[5]**	**A1** for one correct	
9	(i)		–5.7 to –5.8, –2.2 to –2.3, –1 isw	2 **[2]**	**B1** for 2 correct or for all 3 only stated in coordinate form, ignoring y coordinates	

Question			Answer	Marks	Guidance	
9	(ii)		$1=(x+2)(x^2+7x+7)$	M1	condone missing brackets if expanded correctly; or **M1** for correct expansion of $(x+2)(x^2+7x+7)$	
			correct completion with at least one interim stage of working to given answer: $x^3+9x^2+21x+13=0$	A1		
			[$x=-1$ is root so] $(x+1)$ is factor soi	M1	implied by division of cubic by $x+1$	condone some confusion of root/factor for this mark if division of cubic by $x+1$ seen
			correctly finding other factor as $x^2+8x+13$	M2	**M1** for correct division of cubic by $(x+1)$ as far as obtaining x^2+8x (may be in grid) or for two correct terms of $x^2+8x+13$ obtained by inspection	allow seen in grid without + signs
			$\dfrac{-8\pm\sqrt{8^2-4\times13}}{2}$ oe	M1	for use of formula, condoning one error, for $x^2+8x+13=0$	or **M1** for $(x+4)^2=4^2-13$ oe or further stage, condoning one error
			$\dfrac{-8\pm\sqrt{12}}{2}$ isw or $-4\pm\sqrt{3}$ isw and $x=-1$	A1	$x=-1$ may be stated earlier	isw wrong simplification or giving as coordinates
				[7]		

Question			Answer	Marks	Guidance	
9	**(iii)**	**A**	drawing the translated quadratic or showing that the horizontal gap between the relevant parts of the curve is always less than 3 estimated coordinates of the point of intersection (1.8 to 2, 0.2 to 0.3)	B1 B1 **[2]**	must be a reasonable translation of given quadratic, only intersecting given curve once; intersections with x axis –3 to –2.5 and 1.5 to 2; ignore above $y = 1$	
9	**(iii)**	**B**	$y = x^2 + x - 5$ or $y = \left(x + \frac{1}{2}\right)^2 - \frac{21}{4}$	2 **[2]**	**M1** for $[y =]$ $(x - 3)^2 + 7(x - 3) + 7$ oe or for simplified equation with '$y =$' omitted or for $y = (x - a)(x - b)$ where a and b are the values $3 + \frac{-7 \pm \sqrt{21}}{2}$ oe (may have been wrongly simplified)	M0 for use of estimated roots in (A)

Question			Answer	Marks	Guidance	
10	(i)		[Grad AB =] $\frac{7-3}{2-0}$ or $\frac{4}{2}$	M1		
			[Grad BC =] $\frac{-1-3}{8-0}$ or $\frac{-4}{8}$	M1		allow just a simplified version of 2 or –½ for one method mark, but for both to be gained, there must be evidence that the gradients have been obtained independently
			product of gradients = –1 [when lines are at right angles]	A1	or 'negative reciprocal [so perpendicular] oe; may be implied by correct calculation	may be seen earlier, but correct working must support the statement
			or	**or**		
			$AB^2 = 2^2 + 4^2$ [=20] , $BC^2 = 8^2 + 4^2$ [=80] and $AC^2 = 6^2 + 8^2$ [= 100]	M2	or equiv for AB etc; allow at unsimplified stage; or **M1** for just one correct expression for one of the sides	allow just a simplified version of eg $AB^2 = 20$ for one method mark, but for both to be gained, there must be evidence that the lengths or their squares have been obtained independently
			$AB^2 + BC^2 = AC^2$ [so by Pythagoras, angle ABC = 90°] oe	A1	may be implied by correct calculation	may be seen earlier, but correct working must support the statement
				[3]		another possible method: M1 for finding midpt ofAC as (5, 3), M1 for showing dist from midpt to A, B and C is 5 and M1 for using angle in a semicircle to show that ABC = 90°

Question			Answer	Marks	Guidance	
10	(ii)		centre D = $\left(\frac{2+8}{2}, \frac{7+-1}{2}\right)$ or (5, 3) soi	B1	may be implied by circle eqn	if already found in (i), must be used in (ii) to get the mark here
			radius = 5 or r^2 = 25 or for finding dist between A, B or C and their centre D oe	B1	may be implied by circle eqn	if already found in (i), must be used in (ii) to get the mark here
			$(x-a)^2+(y-b)^2=r^2$ soi	M1	general formula may be quoted or implied by eqn using their values, but it must be clear that they are using their r^2 rather than their r or their d or d^2	for this method mark, allow use of their values, even if obtained from AB or BC as diameter
			$(x-5)^2+(y-3)^2=25$ or 5^2 isw	A1	alternative method: allow B4 for $(y-7)(y+1)+(x-2)(x-8)=0$	
				[4]		
10	(iii)		[grad AD =] $\frac{7-3}{2-5}$ isw or $-\frac{4}{3}$ oe	B1	or may use CD $\left(\frac{-1-3}{8-5}\right)$, AC $\left(\frac{7-(-1)}{2-8}\right)$ or ft their D from (ii) or **B1** for correct differentiation: $2x+2y\frac{dy}{dx}-10-6\frac{dy}{dx}=0$ oe	if D wrong, check back to (ii) for any ft NB: A(2, 7) B(0, 3) and C(8, –1)
			grad tgt = ¾ oe www or –1/ their grad AD oe	M1		
			y – 7 = their ¾ (x – 2) or $7 = \text{their } \frac{3}{4}\times 2 + c$	M1	**M0** if grad AD used; **M0** for a spurious gradient used	perp gradient to AB or BC used: may earn 2nd M1 only
			$4y = 3x + 22$ oe where a, b, c are integers, isw	A1	allow correct answer to imply 3rd M1, provided first two Ms have been earned	
				[4]		

Question			Answer	Marks	Guidance	
11	**(i)**		(0, –3)	B1	condone $y = -3$, isw	if not coordinates, must be clear which is x and which is y
			(– ½ , 0) and (3, 0) www	B2	condone $x = -½$ and 3; **B1** for one correct www or **M1** for $(2x + 1)(x - 3)$ or correct use of formula or reversed coordinates	
				[3]		
11	**(ii)**		$2x^2 - 6x - 6$[= 0] isw or $x^2 - 3x - 3$ [= 0] or $2y^2 - 18y + 30$ [=0]	M1	for equating curve and line, and rearrangement to zero, condoning one error	allow rearranging to constant if they go on to attempt completing the square
			use of formula or completing the square, with at most one error	M1	no ft from $2x^2 - 6x = 0$ or other factorisable equations	if completing the square must get to the stage of complete square only on lhs as in 9(ii)
			$\left(\frac{6\pm\sqrt{84}}{4},\frac{18\pm\sqrt{84}}{4}\right)$ or $\left(\frac{3\pm\sqrt{21}}{2},\frac{9\pm\sqrt{21}}{2}\right)$ oe isw	A2	**A1** for one set of coords or for x values correct (or ys from quadratic in y); need not be written as coordinates	A0 for unsimplified y coords eg $\frac{3+\sqrt{21}}{2}+3$
				[4]		

Question			Answer	Marks	Guidance	
11	**(iii)**		$2x^2 - 5x - 3 = x + k$	M1	for equating curve and line	
			$2x^2 - 6x - 3 - k$ [= 0]	M1	for rearrangement to zero, condoning one error, but must include k ;this second M1 implies the first, eg it may be obtained by subtracting the given equations	
			$b^2 - 4ac < 0$ oe for non-intersecting lines	M1	eg allow for just quoting this condition; may be earned near end with correct inequality sign used there allow 'discriminant is negative' if further work implies $b^2 - 4ac$	some may use condition for intersecting lines or for a tangent and then swap condition at the end; only award this M1 and the final A mark if the work is completely clear
			$36 - 8 \times -(3 + k)$ [< 0] oe	A1	for correct substitution into $b^2 - 4ac$; no ft from wrong equation; if brackets missing or misplaced, must be followed by a correct simplified version	can be earned with equality or wrong inequality, or in formula – this mark is not dependent on the 3rd M mark;
			$k < -\frac{15}{2}$ oe	A1	isw if 3rd M1 not earned, allow **B1** for $-\frac{15}{2}$ obtained for k with any symbol	

Question			Answer	Marks	Guidance	
11	**(iii) cont**		or, for those using a tangent condition with trials to find the boundary value			mark one mark scheme or another, to the advantage of the candidate, but not a mixture of schemes
			rearrangement with correct boundary value of k eg $2x^2 - 6x + 4.5$ [= 0] or $2x^2 - 6x - (3 - 7.5)$ [= 0]	M2	**M1** for $2x^2 - 5x - 3 = x - 7.5$	M0 for trials with wrong values without further progress, though may still earn an M1 for $b^2 - 4ac < 0$
			showing $36 - 8 \times -(3 - 7.5) = 0$ or $36 - 8 \times 4.5 = 0$ oe	M1	may be in formula implies previous M2	
			$k < -\frac{15}{2}$ oe	A2	**B1** for $-\frac{15}{2}$ obtained for k as final answer with any symbol	
			or, for using tangent with differentiation			
			$y' = 4x - 5$	M1		
			[when $y = x + k$ is tgt] $4x - 5 = 1$	M1		
			$x = 1.5$, $y = -6$	A1		
			$-6 = 1.5 + k$ or $k = -7.5$ oe	A1		
			$k < -7.5$ oe	A1		
				[5]		

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

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; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

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

PART OF THE CAMBRIDGE ASSESSMENT GROUP

4751 Introduction to Advanced Mathematics (C1)

General Comments:

As last June, having had a whole year to prepare for this examination, candidates were in general 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.

Although the majority of candidates used the surds competently in question 5, there were a lot of errors when trying to simplify their roots in 9(ii) and 11(ii) and it was fortunate for them that subsequent work was ignored after acceptable answers in those parts. In general, candidates who opted to complete the square rather than use the formula did so badly. Quite a few candidates did not appreciate fully the difference between 'solving an equation in *x*' and giving coordinates, with many losing a mark in 9(i) because of this. Also there was often confusion between roots and factors, especially evident in the language candidates used in 9(ii).

As usual, some candidates made arithmetical errors on this non-calculator paper. This was evident in the fractions in question 2, as expected, but also in evaluating the coefficients in the binomial theorem, and the radius in question 10(ii), as well as the quadratic formula and the discriminant in the later parts of question 11.

Comments on Individual Questions:

Section A

Question No. 1
Nearly all candidates interpreted the zero power correctly in the first part. Most interpreted the fractional power correctly in the second part, although a number of candidates began by attempting to cube 9, which usually ran into difficulties as candidates did not have the assistance of their calculators; they had similar issues when attempting to find the square root 729. The most common error was candidates believing that 3 cubed was 9. Coping with the fraction and negative power in the last part was usually done correctly; notable errors were inverting the fraction whilst losing the power altogether or losing the power from either the numerator or denominator.

Question No. 2
This was a good source of marks for the majority of candidates, who found the demand of solving a pair of simultaneous equations relatively straightforward, although errors in coping with the fractional answer to x to find the y-value were quite common, as was occasionally forgetting to find the y-value. Very few candidates found the y-value first. Those who used substitution and wrote down $2x + 3(7 – 3x) = 12$ nearly always went on to get the correct answer for x – although it was particularly disheartening the number of times that $7x = 9$ became $x = 7/9$. Those who substituted for y and had $y = 7 – 3((12 – 3y)/2)$ were usually less successful, due to the fraction and the number of negative terms in the equation. Elimination methods were less frequently seen and not as successful – candidates often did not multiply all values by the required constant or they added or subtracted their pair of equations incorrectly.

Question No. 3
Nearly all candidates knew how to solve a linear inequality for the first part, and earned at least one of the two marks. When the rearrangement was done so that that the $2x$ term appeared on the right, already positive (so $-11 > 2x$) the vast majority of candidates went on to get the correct answer. However, when candidates arranged to $-2x > 11$, a considerable number neglected to reverse the inequality sign when dividing by the negative value of 2. While the majority of

candidates scored both marks in the second part, a number failed to expand $(5c^2d)^3$ correctly, with many of these failing to cube the 5. It was common for candidates to achieve at least two correct elements – with nearly all getting c^{10} and an equal split between those getting one of 250 or d^{-2}. Some candidates failed to deal with the two *d* terms correctly in both the numerator and denominator with many of these giving an answer of d^2.

Question No. 4
The majority of the candidates were very familiar with the topic of rearranging to make a different variable the subject of a formula, and coped well with this example. Nearly all candidates correctly multiplied by (2*c* – 5) to give *a*(2*c* – 5) = 3*c* + 2*a*. However it was surprising that a large number of candidates went on to make *c* rather than *a* the subject of the formula (albeit the majority did this correctly and scored 3 of the 4 marks available). Where errors occurred it was usually sign errors from moving terms from one side to the other and a small minority did not simplify their answers fully, giving say an answer of *a* = 3*c* / (2*c* – 5 – 2). It was pleasing to see that the majority of candidates correctly factorised their *a* (or *c*) terms as this has in the past caused issues.

Question No. 5
The first part was nearly always correct with the vast majority scoring at least one mark for correctly stating that $\sqrt{50} = 5\sqrt{2}$. Some candidates had difficulty with $3\sqrt{8}$ and a number incorrectly gave this as $5\sqrt{2}$ which typically came from the incorrect working of $3\sqrt{8} = 3(2\sqrt{2}) = (3+2)\sqrt{2} = 5\sqrt{2}$. In the second part, most candidates clearly knew how to rationalise the denominator with nearly all correctly indicating the need to multiply both numerator and denominator by $(4+\sqrt{3})$; only a small minority incorrectly multiplied by either $(4-\sqrt{3})$ or $\sqrt{3}$. Nearly all correctly achieved a value of 13 for the denominator but some had issues with either expanding or simplifying the numerator. A significant minority who achieved $\frac{26+13\sqrt{3}}{13}$ did not simplify this correctly with $2+13\sqrt{3}$ being a common incorrect answer.

Question No. 6
Binomial expansion was done well in comparison with previous years. Most candidates remembered to use the correct coefficients and were comfortable multiplying them with powers of 5. There were not too many arithmetic errors.

Question No. 7
Most candidates managed to solve the equation. Quite a number of candidates multiplied out the brackets and rearranged to form a quadratic equation in the traditional form. This was then usually solved by factorisation, but occasionally using the formula. Those who used the given form and took the square root of both sides were more inclined to find just one root, by ignoring the possibility that the square root of 9 could be −3. The quality of the parabolas varied enormously, but most candidates determined the coordinates of the turning point and made a good attempt. Some candidates did not consider the turning point and often had skewed parabolas with a minimum on the *y*-axis. A few candidates sketched cubics and received no marks.

Question No. 8
This question was well done by many of the candidates, but a few had no idea how to use the information about the remainder. Nearly all used the fact that f(2) = 11 to find one equation. A few errors were made in applying the remainder theorem by putting f(1) = 8, rather than f(−1). Those who tried to determine this second equation by doing the long division were usually unsuccessful. Having found the two equations, candidates nearly always came up with the correct solutions.

Section B

Question No. 9
(i) About the same number of candidates gave the coordinates of intersection of the two graphs as gave the requested roots of the given equation in *x*. A few misread from the graph and/or struggled with the scale.

(ii) In the main this part was completed well, with almost all candidates gaining the first two marks for multiplying by (x+2) and expanding to prove the stated equality. A significant number of candidates were unable to progress further, unsure of how to solve a cubic equation. Stronger candidates produced a well-organised solution, leading directly to the fully factorised expression (sometimes in only a few lines of working, having used the root of $x = -1$ from the graph and/or part (i) to obtain the first factor). The majority were able to find the correct quadratic following division by (x + 1), with a few using synthetic division and a sizeable minority finding the solution by inspection. At this stage many found the correct final solution, but a significant number failed to include $x = -1$ in their final solution to this question, or stated incorrectly that (x + 1) was a root.

(iii)(*A*) Many candidates were able to translate correctly although there were issues with the intersections on the *x*-axis for some. Quite a few candidates pointed out the intersection but did not write down the coordinates as requested.

(iii)(*B*) Many candidates failed to recognise that they should substitute ($x - 3$) for *x* in the original equation, with a variety of different methods attempted. Substituting (x + 3) was quite a common error, as was adding 3 to the original equation, or changing the constant term to −5. Some used estimated roots. Many failed to gain full marks because they omitted '*y* =' from their final answer.

Question No. 10
(i) The gradient method was the most common. Most candidates showed how their gradients were obtained – it was not sufficient to quote 2 and – ½, since for proof, evidence was needed that the gradients were independently obtained. Some candidates did not obtain the final mark, merely saying that the gradients are perpendicular; a reason was needed, for instance stating that $2x - ½ = -1$, or stating that the gradients are negative reciprocals of each other. The other popular method was to calculate the lengths of the sides of triangle ABC and use Pythagoras's theorem, which was usually well done, although some candidates sadly confused squares and square roots, such as stating $\sqrt{20}+\sqrt{80}=\sqrt{100}$.

(ii) The centre was usually found correctly. The radius caused more problems with some calling AC the radius instead of the diameter, and others reaching $\sqrt{100}/2$ but then making an error. The form of the circle equation was not always correct, with sign errors seen on the left-hand side as well as the right-hand side sometimes being *r*, *d*, or d^2 instead of the correct r^2.

(iii) Finding the gradient of the tangent was generally well done, although some used the gradient of AB or the perpendicular to AB as the gradient of the tangent. Some lost the final mark by not writing the equation in the requested form with integer coefficients. A few weak candidates had no idea how to proceed with this part and omitted it.

Question No. 11
(i) Many candidates earned all 3 marks in this part. Some forgot to find the *y*-intercept. A few used the quadratic formula or completed the square, perhaps not realising that factorising was possible.

(ii) The majority of candidates chose the straightforward approach and equated the line and curve given. These candidates most often simplified correctly to a required form and applied the formula. This was often very well carried out. A very good number of candidates earned 3 marks using this approach. Some attempted to complete the square. Those who, sensibly, divided through by 2 before doing so were usually successful – those who did not were less successful.

Most candidates struggled to find and simplify the *y*-coordinates. Some simply omitted them and the many who attempted them often just wrote the *x* coordinates '+ 3' or failed to convert the 3 being added to a fraction of a common denominator to add to the *x*-coordinate. Some candidates made their solution unnecessarily complicated by rearranging the equation of the line and substituting for *x*. These candidates often omitted to take the solitary *y*-term into account and mostly scored no more than the first two marks.

(iii) Some candidates were unable to cope with the constant of the equation they had formed being in terms of *k*. Many equated the line and curve, as before, and found $2x^2 - 6x - 3 - k = 0$ and then, rather than applying $b^2 - 4ac < 0$, they wrote $2x^2 - 6x - 3 = k$ and tried to apply $b^2 - 4ac < 0$ to the left hand side. Those who did work with $2x^2 - 6x - 3 - k = 0$ were almost always successful. Some candidates made sign errors through carelessness. Some introduced wrong brackets into their equation in an attempt to group the *c* term, such as $-(3 - k)$. Some candidates correctly substituted into $b^2 - 4ac < 0$ but were unable to multiply out correctly. The result $36 - 8 - (3 + k)$ was not uncommon amongst these candidates. Other candidates used trials on $2x^2 - 6x - 3 - k = 0$ to find the boundary value ie the constant that gave $b^2 - 4ac = 0$. These often scored 3 marks, but sign errors usually resulted in the loss of the final 2 marks. A very few candidates used a calculus approach. In most cases, once $y' = 4x - 5$ had been found, it was equated to 0 and the minimum point established, thinking that this would be helpful, then no further progress was made. Candidates' setting out in this question was often poor and difficult to make sense of – particularly if they had had several attempts or had used trials. Some candidates lost marks as they restarted several times, with each time being worth less than the previous attempt! Candidates should take care in this regard – and indicate which of their attempts they intend to be taken as the answer in these cases.

GCE Mathematics (MEI)

				Max Mark	a	b	c	d	e	u
4751	01	C1 – MEI Introduction to advanced mathematics (AS)	Raw	72	63	57	52	47	42	0
			UMS	100	80	70	60	50	40	0
4752	01	C2 – MEI Concepts for advanced mathematics (AS)	Raw	72	56	49	42	35	29	0
			UMS	100	80	70	60	50	40	0
4753	01	(C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	58	52	47	42	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	64	57	51	45	39	0
			UMS	100	80	70	60	50	40	0
4755	01	FP1 – MEI Further concepts for advanced mathematics (AS)	Raw	72	59	53	48	43	38	0
			UMS	100	80	70	60	50	40	0
4756	01	FP2 – MEI Further methods for advanced mathematics (A2)	Raw	72	60	54	48	43	38	0
			UMS	100	80	70	60	50	40	0
4757	01	FP3 – MEI Further applications of advanced mathematics (A2)	Raw	72	60	54	49	44	39	0
			UMS	100	80	70	60	50	40	0
4758	01	(DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	67	61	55	49	43	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	58	50	43	36	29	0
			UMS	100	80	70	60	50	40	0
4762	01	M2 – MEI Mechanics 2 (A2)	Raw	72	59	53	47	41	36	0
			UMS	100	80	70	60	50	40	0
4763	01	M3 – MEI Mechanics 3 (A2)	Raw	72	60	53	46	40	34	0
			UMS	100	80	70	60	50	40	0
4764	01	M4 – MEI Mechanics 4 (A2)	Raw	72	55	48	41	34	27	0
			UMS	100	80	70	60	50	40	0
4766	01	S1 – MEI Statistics 1 (AS)	Raw	72	59	52	46	40	34	0
			UMS	100	80	70	60	50	40	0
4767	01	S2 – MEI Statistics 2 (A2)	Raw	72	60	55	50	45	40	0
			UMS	100	80	70	60	50	40	0
4768	01	S3 – MEI Statistics 3 (A2)	Raw	72	60	54	48	42	37	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	48	43	38	34	30	0
			UMS	100	80	70	60	50	40	0
4772	01	D2 – MEI Decision mathematics 2 (A2)	Raw	72	55	50	45	40	36	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	55	49	44	39	33	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	47	39	32	25	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	59	52	46	40	34	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	59	52	46	40	34	0
		UMS	100	80	70	60	50	40	0
G246	01 Decision 1 MEI	Raw	72	48	43	38	34	30	0
		UMS	100	80	70	60	50	40	0

Level 3 Certificate and FSMQ raw mark grade boundaries June 2016 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 2016							
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	55	47	39	31	23	0
H866	02 Critical maths	Raw	60	47	41	35	29	23	0
		Overall	132	111	96	81	66	51	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	55	47	39	31	23	0
H867	02 Statistical problem solving	Raw	60	40	34	28	23	18	0
		Overall	132	103	88	73	59	45	0

Advanced Free Standing Mathematics Qualification (FSMQ)

			Max Mark	a	b	c	d	e	u
6993	01 Additional Mathematics	Raw	100	59	51	44	37	30	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

OCR
Oxford Cambridge and RSA

Version	Details of change
1.1	Correction to Overall grade boundaries for H866
	Correction to Overall grade boundaries for H867