OCR
Oxford Cambridge and RSA

Wednesday 13 May 2015 – 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

3265130452

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.

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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 Make r the subject of the formula $A = \pi r^2(x+y)$, where $r > 0$. **[2]**

2 A line L is parallel to $y = 4x+5$ and passes through the point $(-1, 6)$. Find the equation of the line L in the form $y = ax+b$. Find also the coordinates of its intersections with the axes. **[5]**

3 Evaluate the following.

(i) 200^0 **[1]**

(ii) $\left(\frac{25}{9}\right)^{-\frac{1}{2}}$ **[3]**

4 Solve the inequality $\frac{4x-5}{7} > 2x+1$. **[3]**

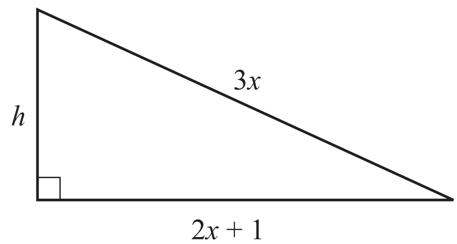
5 Find the coordinates of the point of intersection of the lines $y = 5x-2$ and $x+3y = 8$. **[4]**

6 **(i)** Expand and simplify $(3+4\sqrt{5})(3-2\sqrt{5})$. **[3]**

(ii) Express $\sqrt{72}+\frac{32}{\sqrt{2}}$ in the form $a\sqrt{b}$, where a and b are integers and b is as small as possible. **[2]**

7 Find and simplify the binomial expansion of $(3x-2)^4$. **[4]**

8 Fig. 8 shows a right-angled triangle with base $2x+1$, height h and hypotenuse $3x$.



Not to scale

Fig. 8

(i) Show that $h^2 = 5x^2-4x-1$. **[2]**

(ii) Given that $h = \sqrt{7}$, find the value of x, giving your answer in surd form. **[3]**

9 Explain why each of the following statements is false. State in each case which of the symbols $\Rightarrow$, $\Leftarrow$ or $\Leftrightarrow$ would make the statement true.

(i) ABCD is a square $\Leftrightarrow$ the diagonals of quadrilateral ABCD intersect at 90° **[2]**

(ii) x^2 is an integer $\Rightarrow$ x is an integer **[2]**

Section B (36 marks)

10 You are given that $\mathrm{f}(x) = (x+3)(x-2)(x-5)$.

(i) Sketch the curve $y = \mathrm{f}(x)$. **[3]**

(ii) Show that f(x) may be written as $x^3 - 4x^2 - 11x + 30$. **[2]**

(iii) Describe fully the transformation that maps the graph of $y = \mathrm{f}(x)$ onto the graph of $y = \mathrm{g}(x)$, where $\mathrm{g}(x) = x^3 - 4x^2 - 11x - 6$. **[2]**

(iv) Show that $\mathrm{g}(-1) = 0$. Hence factorise $\mathrm{g}(x)$ completely. **[5]**

11

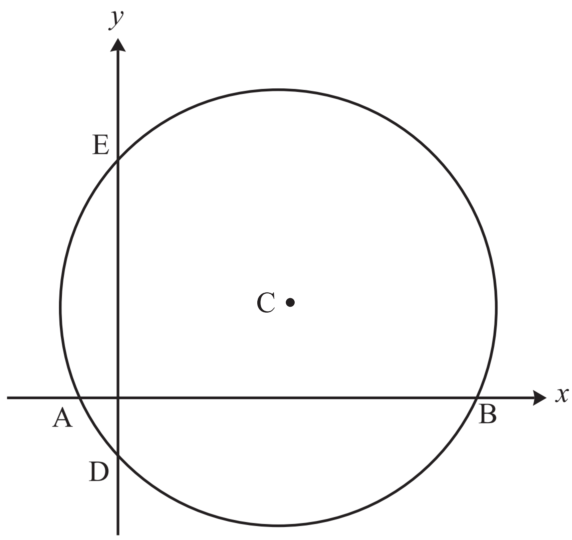


Fig. 11

Fig. 11 shows a sketch of the circle with equation $(x-10)^2 + (y-2)^2 = 125$ and centre C. The points A, B, D and E are the intersections of the circle with the axes.

(i) Write down the radius of the circle and the coordinates of C. **[2]**

(ii) Verify that B is the point (21, 0) and find the coordinates of A, D and E. **[4]**

(iii) Find the equation of the perpendicular bisector of BE and verify that this line passes through C. **[6]**

12 **(i)** Find the set of values of k for which the line $y = 2x + k$ intersects the curve $y = 3x^2 + 12x + 13$ at two distinct points. **[5]**

(ii) Express $3x^2 + 12x + 13$ in the form $a(x+b)^2 + c$. Hence show that the curve $y = 3x^2 + 12x + 13$ lies completely above the x-axis. **[5]**

(iii) Find the value of k for which the line $y = 2x + k$ passes through the minimum point of the curve $y = 3x^2 + 12x + 13$. **[2]**

END OF QUESTION PAPER

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PRINTED ANSWER BOOK

Candidates answer on this Printed Answer Book.

OCR supplied materials:
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- MEI Examination Formulae and Tables (MF2)

Other materials required:
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Duration: 1 hour 30 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

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Section A (36 marks)

1	
2	
3 (i)	
3 (ii)	

4	
5	
6 (i)	

6 (ii)	
7	
8 (i)	

8 (ii)	
9 (i)	
9 (ii)	

Section B (36 marks)

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

10 (iv)

11 (i)	
11 (ii)	

11 (iii)

12 (i)

12 (ii)	
12 (iii)	

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Annotations and abbreviations

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

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

a Annotations should be used whenever appropriate during your marking.

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

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

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

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

c The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

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

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

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

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

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

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

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

g Rules for replaced work

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

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

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

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

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

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

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

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

Question			Answer	Marks	Guidance	Question
8	(i)		$(3x)^2 = h^2 + (2x+1)^2$ oe	B1	for a correct Pythagoras statement for this triangle, in terms of x, with correct brackets	condone another letter instead of h for one mark but not both unless recovered at some point
			$9x^2 = h^2 + 4x^2 + 4x + 1$ and completion to given answer , $h^2 = 5x^2 - 4x - 1$	B1 [2]	for correct expansion, with brackets or correct signs; must complete to the given answer with no errors in any interim working may follow $3x^2 = h^2 + (2x+1)^2$ oe for **B0 B1**	eg B1 for $h^2 = 9x^2 - (4x^2 + 4x + 1)$ and completion to correct answer but B0 for $h^2 = 9x^2 - 4x^2 + 4x + 1$
8	(ii)		[0 =] $5x^2 - 4x - 8$	B1	for subst and correctly rearranging to zero	
			$\frac{4 \pm \sqrt{(-4)^2 - 4\times5\times-8}}{2\times5}$ or ft	M1	for use of formula in their eqn rearranged to zero, condoning one error; ft only if their rearranged eqn is a 3-term quadratic; no ft from $5x^2 - 4x - 1$ [=0]	or M1 for $\left(x - \frac{2}{5}\right)^2 = \left(\frac{2}{5}\right)^2 + \frac{8}{5}$ oe, (condoning one error), which also implies first M1 if not previously earned M0 for factorising ft
			$\frac{4+\sqrt{176}}{10}$ or $\frac{2}{5} + \frac{\sqrt{44}}{5}$ oe	A1 [3]	isw wrong simplification; **A0** if negative root also included	
9	(i)		the diagonals of a rhombus also intersect at 90°	B1	oe for kite or other valid statement/sketch **B0** if eg rectangle or parallelogram etc also included as having diagonals intersecting at 90°	accept 'diamond' etc reference merely to 'other shapes' having diagonals intersecting at 90° is not sufficient; sketches must have diagonals drawn, intersecting approx. at right angles but need not be ruled
			ABCD is a square ⇒ the diagonals of quadrilateral ABCD intersect at 90°	B1 [2]	oe; **B0** if no attempt at explanation (explanation does not need to gain a mark)	Do not accept → oe

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

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

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

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

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

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

4751 Introduction to Advanced Mathematics (C1)

General Comments:

Candidates now have a whole year to prepare for this examination. As last June, the first year in which there was no January examination, examiners found that many candidates were confident in applying the skills needed for this unit. For instance, greater familiarity with the circle equation meant that finding the intersections of a circle with the axes was done better than it used to be in some sessions. Candidates found most of the questions accessible, with most attempting all parts. Questions that were found most difficult were q9 and 12(i) and (iii).

Candidates' arithmetic skills without a calculator remain variable however, and many errors were seen in coping with fractions (questions 3 and 5 particularly) and multiplying in question 7; and in coping with negatives/subtraction in several questions such as 8(i), 11(iii) and 12(i).

Comments on Individual Questions:

Section A

Question 1

This proved to be a routine, straight-forward question for the majority of the candidates who were familiar with the topic of rearranging to make a different variable the subject of a formula. When only one of the two marks was awarded, it was often due to candidates not realising that the question specifically stated that $r > 0$ and so some gave an answer involving +/-. Occasionally this mark was awarded on the follow through for those candidates who correctly took the positive square root of their (incorrect) expression for r^2. Triple decker fractions were occasionally seen, which did not earn full marks if left in the final answer. A handful of candidates did not make their square root symbol long enough to cover both the numerator and denominator; very few candidates used a power of half, which would have made this particular issue obsolete.

Question 2

The majority of candidates correctly found the equation of the line and went on to find the intersection points as coordinates with the axes. A number of candidates used a perpendicular gradient (of $-\frac{1}{4}$) for their line and a number had issues when simplifying $y - 6 = 4(x + 1)$ or when substituting $(-1, 6)$ into $y = 4x + c$, but usually the first three marks were routinely obtained. Unfortunately a number of candidates did not realise that the question still had a further two demands and finished with stating that $y = 4x + 10$. Of those that did find the intersections nearly all correctly stated (0, 10) or $y = 10$ with the most common error being an x-intercept of 10/4 (instead of the correct −10/4). On those rare occasions when the first 3 marks were not awarded then the last two marks were usually earned on the follow through. Very occasionally candidates incorrectly combined their x and y values into a single coordinate.

Question 3

Nearly all candidates interpreted the zero power correctly in the first part. Many correct answers were seen in the second part, but not all could cope with the combination of a negative fractional power and a fraction. Notable errors were inverting the fraction whilst losing the power altogether (or losing it from either the numerator or denominator – so giving an answer of 9/5 or 3/25). A number of candidates left their answer as a triple-decker fraction. Decimal equivalent and +/- were rarely seen.

Question 4

The majority of candidates found this question on solving a linear inequality to be straightforward with nearly all scoring at least two of three marks available. Nearly all candidates started by correctly multiplying up by 7 to remove the fraction, although some made errors in doing so, such as $4x – 5 > 14x + 1$, $28x – 35 > 2x + 1$ or $28x – 35 > 14x + 7$. Usually the rearrangement was then done so that the $10x$ term appeared on the right already positive (so $-12 > 10x$) and in this situation the vast majority of candidates went on to get the correct answer. However, when candidates arranged to $-10x > 12$, a number neglected to reverse the inequality sign when dividing by the negative value of 10. Some candidates replaced the inequality sign with an equals, and used this throughout until a final statement – the method marks for multiplying and rearrangement were still available for such candidates.

Question 5

Again 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. x was usually found first, mostly through substitution of one equation into the other. Those who did use substitution and wrote down $x + 3(5x – 2) = 8$ nearly always went on to get the correct answer for x – although it was disheartening to see the number of times that $16x = 14$ became $x = 16/14$. Those that did have x correct usually went on to find y correctly as well although some candidates, as is always the case in this type of problem, moved on and forgot to find the other value, and some had difficulty in coping with the fractions. Those who substituted for y and had $y = 5(8 – 3y) – 2$ were usually less successful due to 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 6

Many candidates gained all three marks in the first part, with the most common error being wrong evaluation of the term $4\sqrt{5}\times\left(-2\sqrt{5}\right)$. The second part was found much more difficult. Many candidates reached $\sqrt{72}=6\sqrt{2}$ but were unable to combine that correctly with $\frac{32}{\sqrt{2}}$, either not rationalising the denominator of this correctly or often by multiplying both terms by $\sqrt{2}$ with no appreciation that they would then need to divide the resulting 44 by $\sqrt{2}$.

Question 7

Quite a few candidates gained full marks for this binomial expansion. A fair few candidates struggled to cope with the arithmetic, making errors in the calculation of the coefficients, despite demonstrating good understanding of the binomial expansion in their working. Some failed to raise the 3 to the various powers, though usually the −2 was dealt with correctly. Occasionally candidates attempted to take out a factor of three, but some failed to realise that this should lead to a factor of 3^4 outside the bracket.

Question 8

Fewer candidates gained all five marks on this question than in the earlier questions in the paper. In the first part, the most common error was to omit brackets with the $3x^2$ term, though this was often corrected to $9x^2$ in the next line. Another common mistake was to make sign errors when removing brackets from $9x^2 - (4x^2 + 4x + 1)$. Had the answer not been given in the question we might have seen more of these, as there was evidence that some candidates corrected themselves by changing + signs to − signs! It was also quite common to see no mention of h^2 until stating the given result, sometimes with no correct Pythagoras statement given at any point. In part (ii), most reached $5x^2 - 4x - 8 = 0$, though it was not uncommon for the '= 0' to be omitted. A few did not cope correctly with the information $h=\sqrt{7}$ and a few failed to rearrange the equation correctly into an appropriate form. Most correctly substituted into the quadratic formula, with only a small number of candidates not remembering this formula correctly. However, it was extremely common for the final mark to be lost for giving 2 answers and not recognising the need to give the positive solution.

Question 9

Most candidates gained the mark for correcting the symbol in the statement in the first part. However, there were a fair number who did not use the correct notation and wrote e.g. → or ⇨, in spite of the fact that the correct symbols to use were given in the question. Explanations as to why ⇐ was not appropriate were often either incorrect or insufficient. Many thought that a rectangle's diagonals intersect at 90°(or those of a parallelogram or a trapezium), and some appeared not to realise that diagonals were being considered and talked about the internal angles in a rectangle being 90^0. Others did not go far enough to get the mark, just saying that a square is not the only quadrilateral that has diagonals intersecting at 90^0, without giving any example. Correct answers usually mentioned a kite, a rhombus or a diamond as having this property, some with a supporting sketch. A few spoiled their answer by including a rectangle along with the kite or rhombus. In the second part, a common error was to think that the correct symbol was ⇔, thinking that the square of a non-integer was also a non-integer. Some candidates thought that negative whole numbers were not integers. Usually a correct answer was supported by a numeric example of a surd for *x*, though a small number mentioned decimals.

Section B

Question 10

(i) Most candidates had the general shape of the cubic curve correct in their sketch, although some tended to lessen the gradient at the ends so that their curves appeared to approach further turning points. The most common error was to omit the y-intercept.

(ii) Most candidates gained both marks in correctly expanding the factorised form. The few errors were usually in getting the sign of a term wrong or occasionally being careless in writing a power, e.g. writing 4x2 instead of 4x3 in the final answer. Candidates who attempted to expand all three brackets at once were sometimes successful but this approach was more prone to errors than expanding two brackets as a first step.

(iii) Many candidates lost a mark by not using the word translation. Some gave wrong answers such as a double negative 'move down by −36'. Sometimes candidates gave conflicting answers such as 'move by 36 in the *y*-direction' as well as $\begin{pmatrix} 0 \\ -36 \end{pmatrix}$.

(iv) This part was well done, with many candidates gaining full marks. A few did not show explicitly that g(−1) = 0, although nearly all correctly used the fact to attempt further work using (x + 1) as a factor, with only a few attempted divisions by (x – 1) being seen. Most candidates seem well-practiced at division, with most using long division but a substantial minority using inspection. A few candidates failed to factorise the quadratic factor correctly. A few weak candidates only showed that g(−1) = 0, but then did not know how to proceed.

Question 11

(i) The centre and radius were usually given correctly.

(ii) Many began by substituting (21, 0) into the circle equation and showed that the left-hand side equalled 125. Few used a diagram and a direct application of Pythagoras' Theorem. They could then use symmetry to find the coordinates of A, but many did not. The other method was to put y = 0 into the circle equation and solve the ensuing quadratic to obtain both B and A. This was nearly always the method used with x = 0 to find D and E. A few candidates did not know how to proceed, but the majority gained most, if not all the marks in this part.

(iii) Most candidates started correctly in finding the gradient of BE, although this was sometimes wrongly simplified. Some wasted time by finding the equation of BE before realising they needed the perpendicular gradient. It was quite common then to use the coordinates of C to find the equation through C, which was perpendicular to BE, without showing it was the perpendicular bisector (this gained 4 of the 6 marks). Those who approached by finding the midpoint of BE and the equation of the perpendicular bisector and showed that C was on it were often successful in gaining all 6 marks – indeed some were able to find previous errors in their working during this process. Some candidates assumed that C was the midpoint of BE and began by finding the gradient of BC and its perpendicular, which gained no marks.

Question 12

(i) Many candidates struggled to earn more than the first one or two marks with some stopping at 3x2 + 10x + 13 = k and trying to work with the left and side of this equation. The presentation of answers in this part was variable as candidates tried various methods to make progress. Those who went for the more obvious approach of working with the discriminant of the correct equation were often successful – earning 4 or 5 marks (though sign errors were commonplace in these attempts). Those few who attempted methods based on completing the square often made errors, but also achieved some success – generally scoring around 3 marks. Those who used the quadratic formula on the correct equation sometimes confused themselves and stated that it was > 0 rather than the discriminant was > 0. Errors with inequalities were also fairly frequent in this part. Occasionally, attempts using calculus were seen and these also scored reasonably well and were credited, even though not expected in this module.

(ii) Most candidates earned at least 2 marks in their attempts at completing the square – usually for at least having a and b correct. Many candidates were unsuccessful in finding c, as they did not deal with the factor of 3 successfully, with a common wrong answer being c = 9 instead of the correct 1, although a few earned the method mark for 13 − 3 × their b2 or for 13/3 − their b2 – with the latter mark often being awarded for sight of 1/3. Those who expanded 3(x + 2)2 and then realised that all that was required was to add 1 were very successful. A few candidates multiplied out a(x + b)2 + c and then compared coefficients. For the last mark, many were successful in giving a correct or correct follow-through reason for the graph being above the x- axis. However many more simply evaluated a discriminant and, finding it was negative, concluded that the graph was above the x-axis – without giving any extra information to confirm that it was indeed above and not below the axis.

(iii) It was quite frequent for at least a mark to be earned here for the substitution of their minimum point coordinates into the line, although this also required a correct interpretation of their completed square form of the equation. Some candidates found the minimum point using calculus in this part – rather than using their vertex form found in part (ii). For some this was of benefit, as they found the correct point. It was a shame that of these, those who were incorrect in (ii) did not realise their error and revisit that part to correct it. Some totally ignored the *y*-coordinate and equated the equations of the line and curve, then only needing to have a correct *x*-coordinate – generally those who did this were correct in their solutions.

OCR
Oxford Cambridge and RSA

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	48	43	0
			UMS	100	80	70	60	50	40	0
4752	01	C2 – MEI Concepts for advanced mathematics (AS)	Raw	72	56	50	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	56	51	46	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	74	67	60	54	48	0
			UMS	100	80	70	60	50	40	0
4755	01	FP1 – MEI Further concepts for advanced mathematics (AS)	Raw	72	62	57	53	49	45	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	59	52	46	40	34	0
			UMS	100	80	70	60	50	40	0
4758	01	(DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	63	57	51	45	38	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	62	54	46	39	32	0
			UMS	100	80	70	60	50	40	0
4762	01	M2 – MEI Mechanics 2 (A2)	Raw	72	54	47	40	33	27	0
			UMS	100	80	70	60	50	40	0
4763	01	M3 – MEI Mechanics 3 (A2)	Raw	72	64	56	48	41	34	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	54	47	41	35	0
			UMS	100	80	70	60	50	40	0
4767	01	S2 – MEI Statistics 2 (A2)	Raw	72	65	60	55	50	46	0
			UMS	100	80	70	60	50	40	0
4768	01	S3 – MEI Statistics 3 (A2)	Raw	72	64	58	52	47	42	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	56	51	46	41	37	0
			UMS	100	80	70	60	50	40	0
4772	01	D2 – MEI Decision mathematics 2 (A2)	Raw	72	54	49	44	39	34	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	56	50	45	40	34	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	61	54	47	41	35	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	54	47	41	35	0
		UMS	100	80	70	60	50	40	0
G246	01 Decision 1 MEI	Raw	72	56	51	46	41	37	0
		UMS	100	80	70	60	50	40	0