OCR
RECOGNISING ACHIEVEMENT

Monday 13 May 2013 – Afternoon

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

4715620613

INSTRUCTIONS TO CANDIDATES

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

- The Question Paper will be found in the centre of 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 equation of the line which is perpendicular to the line $y = 2x - 5$ and which passes through the point $(4, 1)$. Give your answer in the form $y = ax + b$. **[3]**

2 Find the coordinates of the point of intersection of the lines $y = 3x - 2$ and $x + 3y = 1$. **[4]**

3 **(i)** Evaluate $(0.2)^{-2}$. **[2]**

(ii) Simplify $(16a^{12})^{\frac{3}{4}}$. **[3]**

4 Rearrange the following formula to make r the subject, where $r > 0$.

$$V = \frac{1}{3}\pi r^2(a + b)$$ **[3]**

5 You are given that $f(x) = x^5 + kx - 20$. When $f(x)$ is divided by $(x - 2)$, the remainder is 18. Find the value of k. **[3]**

6 Find the coefficient of x^3 in the binomial expansion of $(2 - 4x)^5$. **[4]**

7 **(i)** Express $125\sqrt{5}$ in the form 5^k. **[2]**

(ii) Simplify $10 + 7\sqrt{5} + \dfrac{38}{1 - 2\sqrt{5}}$, giving your answer in the form $a + b\sqrt{5}$. **[3]**

8 Express $3x^2 - 12x + 5$ in the form $a(x - b)^2 - c$. Hence state the minimum value of y on the curve $y = 3x^2 - 12x + 5$. **[5]**

9 $n - 1$, n and $n + 1$ are any three consecutive integers.

(i) Show that the sum of these integers is always divisible by 3. **[1]**

(ii) Find the sum of the squares of these three consecutive integers and explain how this shows that the sum of the squares of any three consecutive integers is never divisible by 3. **[3]**

Section B (36 marks)

10 The circle $(x-3)^2 + (y-2)^2 = 20$ has centre C.

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

(ii) Find the coordinates of the intersections of the circle with the x- and y-axes. **[5]**

(iii) Show that the points $A(1,6)$ and $B(7,4)$ lie on the circle. Find the coordinates of the midpoint of AB. Find also the distance of the chord AB from the centre of the circle. **[5]**

11 You are given that $f(x) = (2x-3)(x+2)(x+4)$.

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

(ii) State the roots of $f(x-2) = 0$. **[2]**

(iii) You are also given that $g(x) = f(x) + 15$.

(A) Show that $g(x) = 2x^3 + 9x^2 - 2x - 9$. **[2]**

(B) Show that $g(1) = 0$ and hence factorise $g(x)$ completely. **[5]**

[Question 12 is printed overleaf.]

12

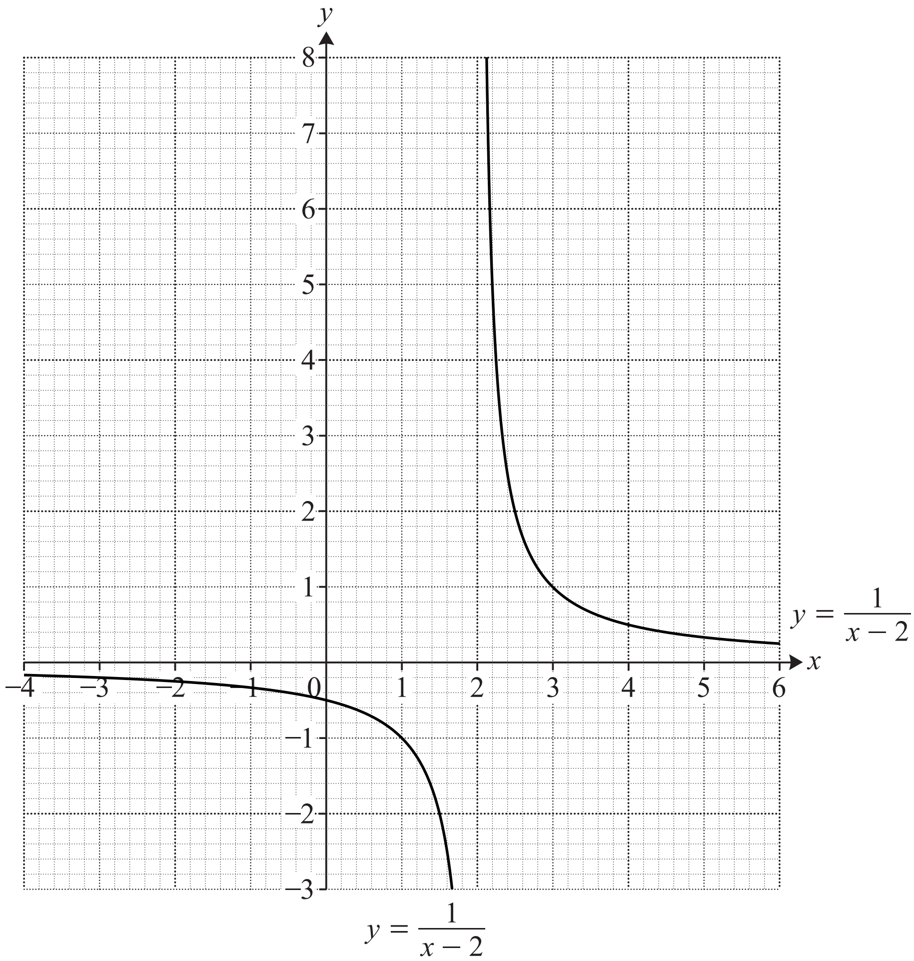

Fig. 12

Fig. 12 shows the graph of $y = \frac{1}{x-2}$.

(i) Draw accurately the graph of $y = 2x + 3$ on the copy of Fig. 12 and use it to estimate the coordinates of the points of intersection of $y = \frac{1}{x-2}$ and $y = 2x + 3$. **[3]**

(ii) Show algebraically that the x-coordinates of the points of intersection of $y = \frac{1}{x-2}$ and $y = 2x + 3$ satisfy the equation $2x^2 - x - 7 = 0$. Hence find the exact values of the x-coordinates of the points of intersection. **[5]**

(iii) Find the quadratic equation satisfied by the x-coordinates of the points of intersection of $y = \frac{1}{x-2}$ and $y = -x + k$. Hence find the exact values of k for which $y = -x + k$ is a tangent to $y = \frac{1}{x-2}$. **[4]**

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OCR supplied materials:
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Other materials required:
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Duration: 1 hour 30 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

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Turn over

Section A (36 marks)

1	
2	
3 (i)	

3 (ii)	
4	
5	

6	
7 (i)	
7 (ii)	

8	
9 (i)	
9 (ii)	

Section B (36 marks)

10 (i)	
10 (ii)	

10 (iii)

11 (i)	
11 (ii)	
11(iii)(*A*)	

11(iii)(*B*)

12 (i)

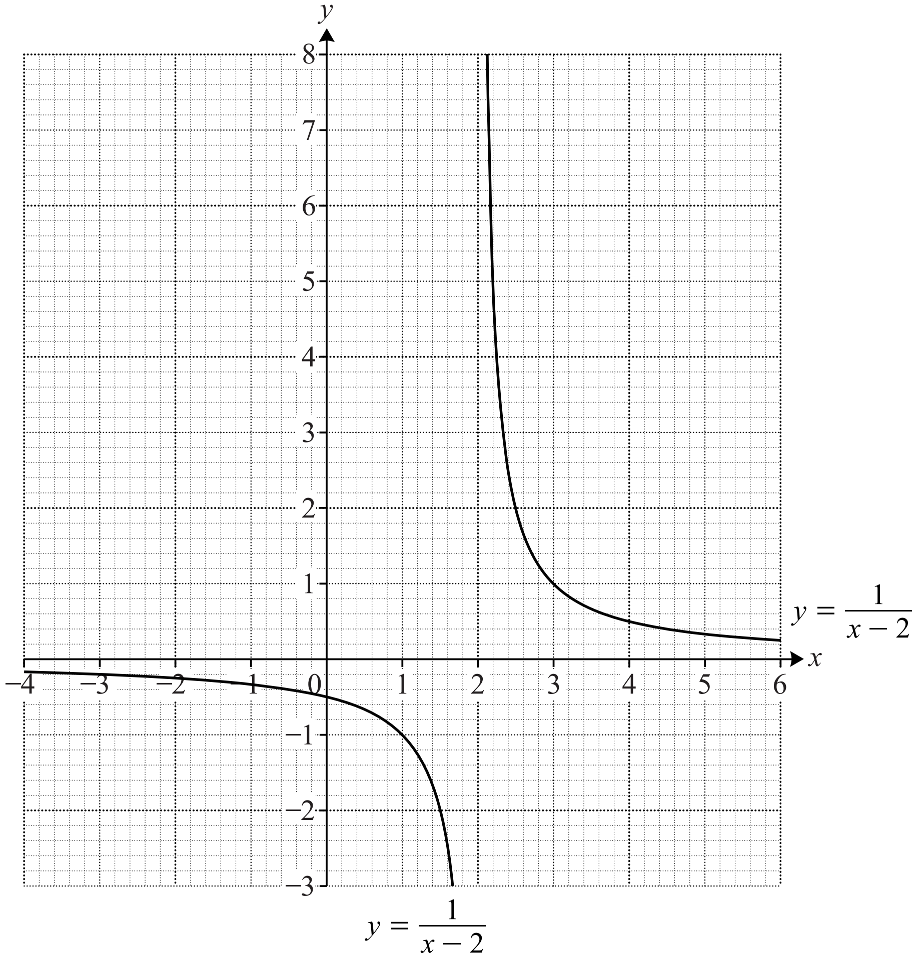

Fig. 12

12 (ii)

12 (iii)	

OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced Subsidiary GCE

Unit **4751:** Introduction to Advanced Mathematics

Mark Scheme for June 2013

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
✓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			$y = -0.5x + 3$ oe www isw	3 **[3]**	B2 for $2y = -x + 6$ oe or M1 for gradient = $-\frac{1}{2}$ oe seen or used and M1 for $y - 1 =$ *their m* $(x - 4)$	for 3 marks must be in form $y = ax + b$ or M1 for $y =$ *their* $mx + c$ and (4, 1) substituted
2			substitution to eliminate one variable simplification to $ax = b$ or $ax - b = 0$ form, or equivalent for y (0.7, 0.1) oe or $x = 0.7$, $y = 0.1$ oe isw	M1 M1 A2 **[4]**	or multiplication to make one pair of coefficients the same; condone one error in either method or appropriate subtraction / addition; condone one error in either method A1 each	 independent of first M1
3	(i)		25	2 **[2]**	M1 for $\left(\frac{10}{2}\right)^2$ or $\left(\frac{1}{0.2}\right)^2$ oe soi or for $\frac{1}{0.04}$ oe	ie M1 for one of the two powers used correctly M0 for just $\frac{1}{0.4}$ with no other working
3	(ii)		$8a^9$	3 **[3]**	B2 for 8 or M1 for $16^{\frac{1}{4}} = 2$ soi and B1 for a^9	ignore ± eg M1 for 2^3; M0 for just 2

4			$r = \sqrt{\dfrac{3V}{\pi(a+b)}}$ oe www as final answer	3 **[3]**	M1 for dealing correctly with 3 and M1 for dealing correctly with $\pi(a + b)$, ft and M1 for correctly finding square root, ft *their* 'r^2 ='; square root symbol must extend below the fraction line	M0 if triple-decker fraction, at the stage where it happens, then ft; condone missing bracket at rh end M0 if ±... or $r >$ ... for M3, final answer must be correct
5			f(2) = 18 seen or used $32 + 2k - 20 = 18$ oe [k =] 3	M1 A1 A1 **[3]**	or long division oe as far as obtaining a remainder (ie not involving x) and equating that remainder to 18 (there may be errors along the way) after long division: $2(k + 16) - 20 = 18$ oe	 A0 for just 2^5 instead of 32 unless 32 implied by further work

6			–2560 www	4 **[4]**	B3 for 2560 from correct term (NB coefficient of x^4 is 2560) or B3 for neg answer following 10 × 4 × –64 and then an error in multiplication or M2 for $10 \times 2^2 \times (-4)^3$ oe; must have multn signs or be followed by a clear attempt at multn; or M1 for $2^2 \times (-4)^3$ oe (condone missing brackets) or for 10 used or for 1 5 10 10 5 1 seen for those who find the coefft of x^2 instead: allow M1 for 10 used or for 1 5 10 10 5 1 seen ; and a further SC1 if they get 1280, similarly for finding coefficient of x^4 as 2560	ignore terms for other powers; condone x^3 included; but eg 10 × 4 × –64 = 40 – 64 = –24 gets M2 only condone missing brackets eg allow M2 for $10 \times 2^2 \times -4x^3$ ${}^5C_3$ or factorial notation is not sufficient but accept $\frac{5\times4\times3\times2\times1}{2\times1\times3\times2\times1}$ oe 10 may be unsimplified, as above M1 only for eg 10, 2^2 and $-4x^3$ seen in table with no multn signs or evidence of attempt at multn [lack of neg sign in the x^2 or x^4 terms means that these are easier and so not eligible for just a 1 mark MR penalty]
7	**(i)**		$5^{3.5}$ oe or $k = 7/2$ oe	2 **[2]**	M1 for $125 = 5^3$ or $\sqrt{5} = 5^{\frac{1}{2}}$ soi	M0 for just answer of 5^3 with no reference to 125

7	**(ii)**		attempting to multiply numerator and denominator of fraction by $1+2\sqrt{5}$	M1		some cands are incorporating the $10+7\sqrt{5}$ into the fraction. The M1s are available even if this is done wrongly or if $10+7\sqrt{5}$ is also multiplied by $1+2\sqrt{5}$
			denominator = −19 soi	M1	must be obtained correctly, but independent of first M1	eg M1 for denominator of 19 with a minus sign in front of whole expression or with attempt to change signs in numerator
			$8+3\sqrt{5}$	A1 **[3]**		
8			$3(x-2)^2-7$ isw or $a = 3$, $b = 2$ $c = 7$ www	4	B1 each for $a = 3$, $b = 2$ oe and B2 for $c = 7$ oe or M1 for $[-]\frac{7}{3}$ or for $5 - their\ a(their\ b)^2$ or for $\frac{5}{3}-(their\ b)^2$ soi	condone omission of square symbol; ignore '= 0' may be implied by their answer
			−7 or ft	B1 **[5]**	B0 for (2, −7)	may be obtained by starting again eg with calculus
9	**(i)**		$3n$ isw	1 **[1]**	accept equivalent general explanation	

9	(ii)		at least one of $(n-1)^2$ and $(n+1)^2$ correctly expanded $3n^2 + 2$ comment eg $3n^2$ is always a multiple of 3 so remainder after dividing by 3 is always 2	M1 B1 B1 **[3]**	must be seen dep on previous B1 B0 for just saying that 2 is not divisible by 3 – must comment on $3n^2$ term as well allow B1 for $\frac{3n^2+2}{3} = n^2 + \frac{2}{3}$	M0 for just $n^2 + 1 + n^2 + n^2 + 1$ accept even if no expansions / wrong expansions seen SC: n, $n + 1$, $n + 2$ used similarly can obtain first M1, and allow final B1 for similar comment on $3n^2 + 6n + 5$
10	(i)		[radius =] $\sqrt{20}$ or $2\sqrt{5}$ isw [centre =] (3, 2)	B1 B1 **[2]**	B0 for $\pm\sqrt{20}$ oe	 condone lack of brackets with coordinates, here and in other questions

10	(ii)		substitution of $x = 0$ or $y = 0$ into circle equation	M1	or use of Pythagoras with radius and a coordinate of the centre eg $20 - 2^2$ or $h^2 + 3^2 = 20$ ft their centre and/or radius	equation may be expanded first, and may include an error bod intent allow M1 for $(x - 3)^2 = 20$ and/or $(y - 2)^2 = 20$
			$(x - 7)(x + 1)$ [=0]	M1	no ft from wrong quadratic; for factors giving two terms correct, or formula or completing square used with at most one error	completing square attempt must reach at least $(x - a)^2 = b$ following use of Pythagoras allow M1 for attempt to add 3 to [±]4
			(7, 0) and (–1, 0) isw	A1	accept $x = 7$ or -1 (both required)	
			$[y =]\dfrac{4 \pm \sqrt{(-4)^2 - 4 \times 1 \times (-7)}}{2}$ oe	M1	no ft from wrong quadratic; for formula or completing square used with at most one error	completing square attempt must reach at least $(y - a)^2 = b$ following use of Pythagoras allow M1 for attempt to add 2 to [±]$\sqrt{11}$
			$(0, 2 \pm \sqrt{11})$ or $\left(0, \dfrac{4 \pm \sqrt{44}}{2}\right)$ isw	A1 **[5]**	accept $y = \dfrac{4 \pm \sqrt{44}}{2}$ oe isw	annotation is required if part marks are earned in this part: putting a tick for each mark earned is sufficient

10	**(iii)**		show both A and B are on circle	B1	explicit substitution in circle equation and at least one stage of interim working required oe	or clear use of Pythagoras to show AC and BC each = $\sqrt{20}$
			(4, 5)	B2	B1 each or M1 for $\left(\frac{7+1}{2}, \frac{6+4}{2}\right)$	
			$\sqrt{10}$	B2	from correct midpoint and centre used; B1 for $\pm\sqrt{10}$ M1 for $(4-3)^2 + (5-2)^2$ or $1^2 + 3^2$ or ft their centre and/or midpoint, or for the square root of this	may be a longer method finding length of ½ AB and using Pythag. with radius; no ft if one coord of midpoint is same as that of centre so that distance formula/Pythag is not required eg centre correct and midpt (3, −1) annotation is required if part marks are earned in this part: putting a tick for each mark earned is sufficient
				[5]		

11	**(i)**		sketch of cubic the right way up, with two tps and clearly crossing the x axis in 3 places	B1		no section to be ruled; no curving back; condone slight 'flicking out' at ends but not approaching another turning point; condone some doubling (eg erased curves may continue to show); accept min tp on y-axis or in 3rd or 4th quadrant; curve must clearly extend beyond the x axis at both 'ends'
			crossing/reaching the x-axis at –4, –2 and 1.5	B1	intersections must be shown correctly labelled or worked out nearby; mark intent	accept curve crossing axis halfway between 1 and 2 if 3/2 not marked
			intersection of y-axis at –24	B1 **[3]**		NB to find –24 some are expanding f(x) here, which gains M1 in iiiA. If this is done, put a yellow line here and by (iii)A to alert you; this image appears again there
11	**(ii)**		–2, 0 and 7/2 oe isw or ft their intersections	2 **[2]**	B1 for 2 correct or ft or for (–2, 0) (0, 0) and (3.5, 0) or M1 for $(x + 2)\,x\,(2x - 7)$ oe or SC1 for –6, –4 and –1/2 oe	

11	**(iii)**	(*A*)	correct expansion of product of 2 brackets of f(x)	M1	need not be simplified; condone lack of brackets for M1 or allow M1 for expansion of all 3 brackets, showing all terms, with at most one error: $2x^3 + 4x^2 + 8x^2 - 3x^2 + 16x - 12x - 6x - 24$	eg $2x^2 + 5x - 12$ or $2x^2 + x - 6$ or $x^2 + 6x + 8$ may be seen in (i) – allow the M1; the part (i) work appears at the foot of the image for (iii)A, so mark this rather than in (i)
			correct expansion of quadratic and linear and completion to given answer	A1 **[2]**	for correct completion if all 3 brackets already expanded, with some reference to show why –24 changes to –9	condone lack of brackets if they have gone on to expand correctly; condone '+15' appearing at some stage NB answer given; mark the whole process

11	**(iii)**	(*B*)	$g(1) = 2 + 9 - 2 - 9$ [=0]	B1	allow this mark for $(x - 1)$ shown to be a factor and a statement that this means that $x = 1$ is a root [of $g(x) = 0$] oe	B0 for just $g(1) = 2(1)^3 + 9(1)^2 - 2(1) - 9$ [=0]
			attempt at division by $(x - 1)$ as far as $2x^3 - 2x^2$ in working	M1	or inspection with at least two terms of quadratic factor correct	M0 for division by $x + 1$ after $g(1) = 0$ unless further working such as $g(-1) = 0$ shown, but this can go on to gain last M1A1
			correctly obtaining $2x^2 + 11x + 9$	A1	allow B2 for another linear factor found by the factor theorem	NB mixture of methods may be seen in this part – mark equivalently eg three uses of factor theorem, or two uses plus inspection to get last factor;
			factorising a correct quadratic factor	M1	for factors giving two terms correct; eg allow M1 for factorising $2x^2 + 7x - 9$ after division by $x + 1$	allow M1 for $(x + 1)(x + 18/4)$ oe after -1 and $-18/4$ oe correctly found by formula
			$(2x + 9)(x + 1)(x - 1)$ isw	A1 **[5]**	allow $2(x + 9/2)(x + 1)(x - 1)$ oe; dependent on 2nd M1 only; condone omission of first factor found; ignore '= 0' seen	SC alternative method for last 4 marks: allow first M1A1 for $(2x + 9)(x^2 - 1)$ and then second M1A1 for full factorisation

12	(i)		$y = 2x + 3$ drawn accurately	M1	at least as far as intersecting curve twice	ruled straight line and within 2mm of (2, 7) and (−1, 1)
			(−1.6 to −1.7, −0.2 to −0.3)	B1	intersections may be in form $x = ..., y = ...$	
			(2.1 to 2.2, 7.2 to 7.4)	B1		
				[3]		if marking by parts and you see work relevant to (ii), put a yellow line here and in (ii) to alert you to look
12	(ii)		$\frac{1}{x-2} = 2x + 3$	M1	or attempt at elimination of x by rearrangement and substitution	may be seen in (i) – allow marks; the part (i) work appears at the foot of the image for (ii) so show marks there rather than in (i)
			$1 = (2x + 3)(x - 2)$	M1	condone lack of brackets	implies first M1 if that step not seen
			$1 = 2x^2 - x - 6$ oe	A1	for correct expansion; need not be simplified; NB A0 for $2x^2 - x - 7 = 0$ without expansion seen [given answer]	implies second M1 if that step not seen after $\frac{1}{x-2} = 2x + 3$ seen
			$\frac{1 \pm \sqrt{1^2 - 4 \times 2 \times -7}}{2 \times 2}$ oe	M1	use of formula or completing square on given equation, with at most one error	completing square attempt must reach at least $[2](x - a)^2 = b$ or $(2x - c)^2 = d$ stage oe with at most one error
			$\frac{1 \pm \sqrt{57}}{4}$ isw	A1	isw eg coordinates; after completing square, accept $\frac{1}{4} \pm \sqrt{\frac{57}{16}}$ or better	
				[5]		

12	(iii)		$\frac{1}{x-2} = -x + k$ and attempt at rearrangement	M1		
			$x^2 - (k+2)x + 2k + 1 [= 0]$	M1	for simplifying and rearranging to zero; condone one error; collection of x terms with bracket not required	eg M1 bod for $x^2 - (k+2)x + 2k$ or M1 for $x^2 - 2kx + 2k + 1 [= 0]$
			$b^2 - 4ac = 0$ oe seen or used	M1		= 0 may not be seen, but may be implied by their final values of k
			[k =] 0 or 4 as final answer, both required	A1	SC1 for 0 and 4 found if 3rd M1 not earned (may or may not have earned first two Ms)	eg obtained graphically or using calculus and/or final answer given as a range
				[4]		

Appendix: revised tolerances for modified papers for visually impaired candidates (graph in 12(i) with 6mm squares)

12	**(i)**		$y = 2x + 3$ drawn accurately	M1	at least as far as intersecting curve twice	ruled straight line and within **3** mm of (2, 7) and (–1, 1)
			(–1.6 to –1.**8**, –0.2 to –0.3)	B1	intersections may be in form $x = ..., y = ...$	
			(2.1 to 2.**3**, 7.**1** to 7.4)	B1		
				[3]		if marking by parts and you see work relevant to (ii), put a yellow line here and in (ii) to alert you to look

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4751 Introduction to Advanced Mathematics (C1)

General Comments

Candidates coped well with this question paper. As commented in previous reports, many candidates are well-drilled in many of the techniques required for this unit, but applying them in unfamiliar situations (such as question 7) is found to be much more difficult.

In general, the standard of algebra was quite good. However, candidates do not always see the need to use brackets correctly. Those who omitted brackets penalised themselves in some questions by then failing to expand brackets correctly or, in question 6, failing to cube the 4. Brackets were formally needed in the answer to question 3, for instance.

Candidates are far happier dealing with whole numbers and quadratic equations that factorise, than they are with fractions, decimals and the use of quadratic formula. In the latter case, when this was necessary, some candidates 'gave up'. Those attempting the completing the square method with fractions were rarely successful.

Comments on Individual Questions

Section A

1) In finding the equation of the line, most candidates obtained full marks. The main mistake was to use a gradient of 2, due to confusion between perpendicular and parallel. There was a significant number of arithmetic errors especially in coping with negative signs and the fraction $-\frac{1}{2}$.

2) In the main, this question was completed well. Some candidates found the arithmetic challenging, especially if rearranging $x + 3y = 1$ to substitute in for y, with the resulting need to cope with fractions. A slight majority choose the substitution method rather than elimination. A few neglected to find y having found x.

3) In evaluating $(0.2)^{-2}$, many stopped after evaluating $\frac{1}{0.2^2}$ as $\frac{1}{0.04}$ (or, sadly often, as $\frac{1}{0.4}$). Those who converted to fractions first were more successful in reaching 25.

   In the second part, the majority found the power of a correctly, but the $16^{\frac{3}{4}}$ proved more challenging. A surprising number did $\frac{3}{4}\times 16 = 12$ to obtain $12a^9$.

4) There were many good answers in rearranging the formula. Most candidates managed at least one mark; some triple-decker fractions or the use of ÷ signs were seen. The π and the ($a + b$) sometimes became separated. The radius was sometimes considered to be ±, and the > sign was used on more than one occasion. It was encouraging to see very few penalties incurred due to a poor square root symbol.

5) Those using f(2) = 18 were usually successful but occasionally 2^5 was miscalculated. A few f(–2) were seen. Those attempting long division were rarely successful, often not knowing how to deal with the term that was to be equated to 18. A few used a grid or 'backwards division' method having realised the constant term in the quotient needed to be 19 to give the correct remainder.

6) Finding the binomial coefficient was done successfully by many candidates, but a surprising number omitted the negative sign in their answer. Virtually all the candidates managed to pick up at least one mark, usually for writing down the binomial coefficient either in Pascal's triangle or as part of an expression. Many candidates wrote down an expression involving the key elements 10, 2^2 and $(-4)^3$, though the brackets were often omitted. It was at this point that some arithmetical errors crept in, in the attempts to calculate 10 × 4 × –64.

7) This question was found to be difficult by many candidates. In the first part, although the correct answer was seen fairly frequently, a significant number of candidates, having correctly shown 125 and $\sqrt{5}$ to be 5^3 and $5^{\frac{1}{2}}$ respectively, then multiplied the indices to give an answer of $5^{\frac{3}{2}}$. Others found one of the indices correctly, but not the other. Some candidates treated it as though the square root applied to 125 as well.

   Few correct answers were seen in the second part. Being in a different format from usual, many candidates did not know how to cope with the initial $10 + 7\sqrt{5}$. Many multiplied the '$10 + 7\sqrt{5}$' term by $2 + \sqrt{5}$, sometimes losing the denominator altogether. Those who knew they should rationalise the denominator of the fraction often made errors in multiplying the denominator, with 9, –9 or 19 often seen (19 often following the correct 1 – 20). Some who correctly reached this point then only divided the first term in the numerator by –19.

8) Some who completed the square correctly lost the final mark by giving the minimum point of (2, –7) rather than the minimum *y*-value. Most common part-correct answers were getting the values of *a* and *b* correct but ignoring the multiple of 3 in establishing any value of *c*. The most common wrong values of *b* were –6 (dividing the '–12*x*' by 2) and 4 (taking the 3 out as a common factor and forgetting to divide by 2).

9) A small number of candidates made no attempt to generalise in either part, and simply gave examples to demonstrate the properties, so, of course, gained no marks. Most earned the mark in the first part for adding the values. In the second part there were some errors in multiplying but many correctly reached $3n^2 + 2$. The last mark was often lost due to an incomplete explanation centred on the fact that 2 was not divisible by 3, without making any reference to the fact that $3n^2$ is always divisible by 3.

Section B

10) (i) Almost all candidates obtained both marks for this part. Some gave 20 for the radius. (–3, –2) was only very occasionally seen.

   (ii) Finding the intersections of the circle with the axes was often well done. Almost all candidates obtained the first mark for substituting $y = 0$ or $x = 0$ in the circle equation, although some then omitted the $(-2)^2$ and/or $(-3)^2$. Some, having correctly found the *x*-intersections, substituted those values instead of starting again by substituting 0 to find the *y* values. Since the correct *y* equation did not factorise, there was distinctly less success in finding the *y* values than the *x* values. Some good solutions using completing the square were seen, after reaching $(y-2)^2 = 11$, for instance, although some omitted the negative square root and then gave just one value.

(iii) Almost all candidates were able to show that A and B lie on the circle, usually by substituting the coordinates or finding the distance between each point and the centre, though some used the longer method of substituting one coordinate and solving the resultant quadratic equation. A few candidates omitted to show that B, as well as A, lies on the circle. Almost all candidates obtained the coordinates of the midpoint of AB (4, 5) successfully, with a small minority subtracting rather than adding. Most candidates realised that the distance of the chord from the centre of the circle was the distance from (4,5) to (3,2) and obtained the correct answer of $\sqrt{10}$. Some calculated the length of AB and proceeded no further; some halved it and used Pythagoras but only a minority were successful with this approach.

11) (i) Most candidates were able to sketch the correct shape for the cubic (the correct way up) and the majority were also able to correctly label the interceptions on the x-axis, although some gave the positive x intercept as ½ or 2/3 or 3. A few candidates failed to label the y-intercept or gave a wrong value such as 12 or -12. Some candidates drew their graph stopping at one of the roots (usually when x = – 4) instead of crossing the x-axis. Only a small number of candidates drew the graph upside-down and a handful drew the wrong shape altogether.

(ii) Quite a few errors were seen here, although a minority knew what to do and wrote down the correct values. Some gave factors or coordinates instead of roots, some solved x – 2 = 0 to give x = 2 as the root, and some went back to the equation but made an algebraic error in replacing x with x – 2, reaching $2x - 5$ as a factor instead of $2x - 7$.

(iii) The first part was generally well done; most correctly expanded two brackets and continued to simplify and add 15 to get the required result. Common errors were: not dealing correctly with the 15 such as saying g(x) = –15 to get the result, and errors in expanding or collecting terms. There was some poor 'mathematical grammar' with the '+15' often appearing out of nowhere.

In part (*B*) most candidates correctly showed g(1) = 0 although some failed to show enough working. Candiates were well-versed, in general, with the techniques of long division or inspection so that most achieved the correct quadratic factor and were able to go on and factorise this to gain full marks. Some tried to use the quadratic formula and then only gave $(x + 1)(x + 4.5)$ oe as factors.

12) (i) Almost all candidates were able to draw the line accurately. Omission of one or both of the signs on the negative intersections was quite common; a few reversed the coordinates. A few just wrote the two x-values only.

(ii) Most were able to obtain the correct equation and many went on to solve it successfully, although as expected, there were some errors in using the formula, especially frequently in evaluating the discriminant after correct substitution.

(iii) After the previous part, most candidates realised that they had to equate the two expressions and manipulate the resulting equation, although many had problems dealing with the '*k*' terms ('$kx + 2x = 2kx$' for instance). Most candidates stopped there, but some realised that they needed to use '$b^2 - 4ac = 0$' to establish the final values of *k*. Some were confused with the *k* and *x* terms and were unable to identify the coefficients correctly or made errors in simplifying the equation. A few candidates used their graphs to establish the results for *k*. A few tried to apply calculus but rarely with any success.

Unit level raw mark and UMS grade boundaries June 2013 series

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	Raw	72	62	56	51	46	41	0
	UMS	100	80	70	60	50	40	0
4752/01 (C2) MEI Concepts for Advanced Mathematics	Raw	72	54	48	43	38	33	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	46	40	33	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
4753 (C3) MEI Methods for Advanced Mathematics with Coursework	UMS	100	80	70	60	50	40	0
4754/01 (C4) MEI Applications of Advanced Mathematics	Raw	90	66	59	53	47	41	0
	UMS	100	80	70	60	50	40	0
4755/01 (FP1) MEI Further Concepts for Advanced Mathematics	Raw	72	63	57	51	45	40	0
	UMS	100	80	70	60	50	40	0
4756/01 (FP2) MEI Further Methods for Advanced Mathematics	Raw	72	61	54	48	42	36	0
	UMS	100	80	70	60	50	40	0
4757/01 (FP3) MEI Further Applications of Advanced Mathematics	Raw	72	60	52	44	36	28	0
	UMS	100	80	70	60	50	40	0
4758/01 (DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	62	56	51	46	40	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
4758 (DE) MEI Differential Equations with Coursework	UMS	100	80	70	60	50	40	0
4761/01 (M1) MEI Mechanics 1	Raw	72	57	49	41	33	25	0
	UMS	100	80	70	60	50	40	0
4762/01 (M2) MEI Mechanics 2	Raw	72	50	43	36	29	22	0
	UMS	100	80	70	60	50	40	0
4763/01 (M3) MEI Mechanics 3	Raw	72	64	56	48	41	34	0
	UMS	100	80	70	60	50	40	0
4764/01 (M4) MEI Mechanics 4	Raw	72	56	49	42	35	29	0
	UMS	100	80	70	60	50	40	0
4766/01 (S1) MEI Statistics 1	Raw	72	55	48	41	35	29	0
	UMS	100	80	70	60	50	40	0
4767/01 (S2) MEI Statistics 2	Raw	72	58	52	46	41	36	0
	UMS	100	80	70	60	50	40	0
4768/01 (S3) MEI Statistics 3	Raw	72	61	55	49	44	39	0
	UMS	100	80	70	60	50	40	0
4769/01 (S4) MEI Statistics 4	Raw	72	56	49	42	35	28	0
	UMS	100	80	70	60	50	40	0
4771/01 (D1) MEI Decision Mathematics 1	Raw	72	58	52	46	40	35	0
	UMS	100	80	70	60	50	40	0
4772/01 (D2) MEI Decision Mathematics 2	Raw	72	58	52	46	41	36	0
	UMS	100	80	70	60	50	40	0
4773/01 (DC) MEI Decision Mathematics Computation	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	44	38	31	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
4776 (NM) MEI Numerical Methods with Coursework	UMS	100	80	70	60	50	40	0
4777/01 (NC) MEI Numerical Computation	Raw	72	55	47	39	32	25	0
	UMS	100	80	70	60	50	40	0
4798/01 (FPT) Further Pure Mathematics with Technology	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 (Z1) Statistics 1	Raw	72	55	48	41	35	29	0
	UMS	100	80	70	60	50	40	0
G242/01 (Z2) Statistics 2	Raw	72	55	48	41	34	27	0
	UMS	100	80	70	60	50	40	0
G243/01 (Z3) Statistics 3	Raw	72	56	48	41	34	27	0
	UMS	100	80	70	60	50	40	0