OCR RECOGNISING ACHIEVEMENT

Monday 14 January 2013 – 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

4733950113

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

This paper has been pre modified for carrier language

Turn over

Section A (36 marks)

1 Find the value of each of the following.

(i) $\left(\frac{5}{3}\right)^{-2}$ **[2]**

(ii) $81^{\frac{3}{4}}$ **[2]**

2 Simplify $\dfrac{(4x^5y)^3}{(2xy^2)\times(8x^{10}y^4)}$. **[3]**

3 A circle has diameter d, circumference C, and area A. Starting with the standard formulae for a circle, show that $Cd = kA$, finding the numerical value of k. **[3]**

4 Solve the inequality $5x^2 - 28x - 12 \leqslant 0$. **[4]**

5 You are given that $\mathrm{f}(x) = x^2 + kx + c$.

Given also that $\mathrm{f}(2) = 0$ and $\mathrm{f}(-3) = 35$, find the values of the constants k and c. **[4]**

6 The binomial expansion of $\left(2x + \frac{5}{x}\right)^6$ has a term which is a constant. Find this term. **[4]**

7 **(i)** Express $\sqrt{48} + \sqrt{75}$ in the form $a\sqrt{b}$, where a and b are integers. **[2]**

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

8 Rearrange the equation $5c + 9t = a(2c + t)$ to make c the subject. **[4]**

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

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

(ii) State the values of x which satisfy $\mathrm{f}(x+3) = 0$. **[2]**

Section B (36 marks)

10 **(i)** Points A and B have coordinates (–2, 1) and (3, 4) respectively. Find the equation of the perpendicular bisector of AB and show that it may be written as $5x + 3y = 10$. **[6]**

(ii) Points C and D have coordinates (–5, 4) and (3, 6) respectively. The line through C and D has equation $4y = x + 21$. The point E is the intersection of CD and the perpendicular bisector of AB. Find the coordinates of point E. **[3]**

(iii) Find the equation of the circle with centre E which passes through A and B. Show also that CD is a diameter of this circle. **[5]**

11 **(i)** Express $x^2 - 5x + 6$ in the form $(x - a)^2 - b$. Hence state the coordinates of the turning point of the curve $y = x^2 - 5x + 6$. **[4]**

(ii) Find the coordinates of the intersections of the curve $y = x^2 - 5x + 6$ with the axes and sketch this curve. **[4]**

(iii) Solve the simultaneous equations $y = x^2 - 5x + 6$ and $x + y = 2$. Hence show that the line $x + y = 2$ is a tangent to the curve $y = x^2 - 5x + 6$ at one of the points where the curve intersects the axes. **[4]**

12 You are given that $f(x) = x^4 - x^3 + x^2 + 9x - 10$.

(i) Show that $x = 1$ is a root of $f(x) = 0$ and hence express $f(x)$ as a product of a linear factor and a cubic factor. **[3]**

(ii) Hence or otherwise find another root of $f(x) = 0$. **[2]**

(iii) Factorise $f(x)$, showing that it has only two linear factors. Show also that $f(x) = 0$ has only two real roots. **[5]**

THERE ARE NO QUESTIONS WRITTEN ON THIS PAGE.

OCR
RECOGNISING ACHIEVEMENT

Monday 14 January 2013 – 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:
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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 (i)	
1 (ii)	
2	
3	

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)	

12 (i)	
12 (ii)	

12 (iii)	

GCE

Mathematics (MEI)

Advanced Subsidiary GCE

Unit **4751:** Introduction to Advanced Mathematics

Mark Scheme for January 2013

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

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

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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

Annotations

Annotation	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

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)**		$\frac{9}{25}$ or 0.36 isw	2 **[2]**	M1 for numerator or denominator correct or for squaring correctly or for inverting correctly	M1 for eg $\frac{1}{\left(\frac{25}{9}\right)}$ or $\left(\frac{25}{9}\right)^{-1}$ or $\frac{25}{9}$ or for $\left(\frac{3}{5}\right)^2$ or $\frac{3}{5}$ M0 for just $\frac{1}{\left(\frac{5}{3}\right)^2}$
1	**(ii)**		27	2 **[2]**	M1 for $81^{\frac{1}{4}} = 3$ soi	eg M1 for 3^3 M0 for $81^3 = 531441$ (true but not helpful)
2			$4x^4y^{-3}$ or $\frac{4x^4}{y^3}$ as final answer	3 **[3]**	B1 each 'term'; or M1 for numerator = $64x^{15}y^3$ and M1 for denominator = $16x^{11}y^6$	B0 if obtained fortuitously mark B scheme or M scheme to advantage of candidate, but not a mixture of both schemes

Question			Answer	Marks	Guidance	
3			obtaining a correct relationship in any 3 of C, d, r and A or obtaining a correct relationship in k and no more than 2 other variables	M2	may substitute into given relationship; or M1 for at least two of $A = \pi r^2$, $C = \pi d$, $C = 2\pi r$, $d = 2r$ or $r = \frac{d}{2}$ seen or used	eg M2 for $Cd = 4\pi r^2$ or $\pi d^2 = k\pi r^2$ seen/obtained condone eg Area $= \pi r^2$; allow $A = \pi\left(\frac{d}{2}\right)^2$ to imply $A = \pi r^2$ and $r = \frac{d}{2}$ and so earn M1, if M2 not earned
			convincing argument leading to $k = 4$	A1 **[3]**	must be from general argument, not just substituting values for r or d; may start from given relationship and derive $k = 4$	eg M1only for eg $A = \pi r^2$ and $C = \pi d$ and so $k = 4$ with no further evidence
4			$(5x + 2)(x - 6)$	M1	for factors giving at least two out of three terms correct when expanded and collected	or use of formula or completing the square with at most one error (comp square must reach $[5](x - a)^2 \leq b$ oe or $(5x - c)^2 \leq d$ oe stage) if correct: $5(x - 2.8)^2 \leq 51.2$ or $(x - 2.8)^2 \leq 10.24$ or $(5x - 14)^2 \leq 256$
			boundary values -0.4 oe and 6 soi	A1	A0 for just $\frac{28 \pm \sqrt{1024}}{10}$	
			$-0.4 \leq x \leq 6$ oe	A2 **[4]**	may be separate inequalities; mark final answer A1 for one end correct eg $x \leq 6$ or for $-0.4 < x < 6$ oe or B1 for $a \leq x \leq b$ ft their boundary values	condone unsimplified but correct $\frac{28 - \sqrt{1024}}{10} \leq x \leq \frac{28 + \sqrt{1024}}{10}$ etc allow A1 for $-0.4 \leq 0 \leq 6$ condone errors in the inequality signs during working towards final answer

Question			Answer	Marks	Guidance	
5			$4 + 2k + c = 0$ or $2^2 + 2k + c = 0$	B1	may be rearranged	
			$9 - 3k + c = 35$	B1	may be rearranged; the $(-3)^2$ must be evaluated / used as 9	condone -3^2 seen if used as 9
			correct method to eliminate one variable from their eqns	M1	eg subtraction or substitution for c; condone one error	M0 for addition of eqns unless also multiplied appropriately
			$k = -6$, $c = 8$	A1	from fully correct method, allowing recovery from slips	if no errors and no method seen, allow correct answers to imply M1 provided B1B1 has been earned
			or $[x^2 + kx + c =]\ (x - 2)(x - a)$	**or** M1	or $(x - 2)(x + b)$	
			$-5 \times (-3 - a) = 35$ oe	M1		
			$a = 4$ $k = -6$, $c = 8$	A1 A1		
				[4]		

Question			Answer	Marks	Guidance	
6			identifying term as $20(2x)^3\left(\frac{5}{x}\right)^3$ oe	M3	condone lack of brackets; M1 for $[k](2x)^3\left(\frac{5}{x}\right)^3$ soi (eg in list or table), condoning lack of brackets and M1 for k = 20 or eg $\frac{6\times5\times4}{3\times2\times1}$ or for 1 6 15 20 15 6 1 seen (eg Pascal's triangle seen, even if no attempt at expansion) and M1 for selecting the appropriate term (eg may be implied by use of only k = 20, but this M1 is not dependent on the correct k used)	xs may be omitted; eg M3 for 20 × 8 × 125 first M1 not earned if elements added not multiplied; otherwise, if in list or table bod intent to multiply M0 for binomial coefficient if it still has factorial notation may be gained even if elements added
			20 000	A1 **[4]**	or B4 for 20 000 obtained from multiplying out $\left(2x+\frac{5}{x}\right)^6$ allow SC3 for 20000 as part of an expansion	
7	(i)		$9\sqrt{3}$ www oe as final answer	2 **[2]**	M1 for $\sqrt{48}=4\sqrt{3}$ or $\sqrt{75}=5\sqrt{3}$ soi	
7	(ii)		$\frac{39+7\sqrt{5}}{44}$ www as final answer	3 **[3]**	M1 for attempt to multiply numerator and denominator by $7-\sqrt{5}$ B1 for each of numerator and denominator correct (must be simplified)	condone $\frac{39}{44}+\frac{7\sqrt{5}}{44}$ for 3 marks eg M0B1 if denominator correctly rationalised to 44 but numerator not multiplied

Question			Answer	Marks	Guidance	
8			$5c + 9t = 2ac + at$	M1	for correct expansion of brackets	
			$5c - 2ac = at - 9t$ oe	M1	for correct collection of terms, ft eg after M0 for $5c + 9t = 2ac + t$ allow this M1 for $5c - 2ac = -8t$ oe	for each M, ft previous errors if their eqn is of similar difficulty;
			$c(5 - 2a) = at - 9t$ oe	M1	for correctly factorising, ft; must be $c \times$ a two-term factor	may be earned before t terms collected
			$[c =] \dfrac{at - 9t}{5 - 2a}$ or $\dfrac{t(a-9)}{5-2a}$ oe as final answer	M1	for correct division, ft their two-term factor	treat as MR if t is the subject, with a penalty of 1 mark from those gained, marking similarly
				[4]		
9	(i)		sketch of cubic the right way up, with two tps	B1		No section to be ruled; no curving back; condone some curving out at ends but not approaching another turning point; condone some doubling (eg erased curves may continue to show); ignore position of turning points for this mark
			their graph touching the x-axis at -2 and crossing it at 3 and no other places	B1	if intns are not labelled, they must be shown nearby	mark intent if 'daylight' between curve and axis at $x = -2$
			intersection of y-axis at -12	B1		if no graph but -12 marked on y-axis, or in table, allow this 3rd mark
				[3]		
9	(ii)		-5 and 0	B2	B1 each; allow B2 for $-5, -5, 0$; or B1 for both correct with one extra value or for $(-5, 0)$ and $(0, 0)$ or SC1 for both of 1 and 6	if their graph wrong, allow -5 and 0 from starting again with eqn, or ft their graph with two intns with x-axis
				[2]		

Question			Answer	Marks	Guidance	
10	(i)		midpt of AB = $\left(\frac{1}{2}, \frac{5}{2}\right)$ oe www	B2	allow unsimplified B1 for one coordinate correct	if working shown, should come from $\left(\frac{3+-2}{2}, \frac{4+1}{2}\right)$ oe NB B0 for x coord. = $\frac{5}{2}$, (obtained from subtraction instead of addition)
			grad AB = $\frac{4-1}{3-(-2)}$ oe	M1	must be obtained independently of given line; accept 3 and 5 correctly shown eg in a sketch, followed by 3/5 M1 for rise/run = 3/5 etc M0 for just 3/5 with no evidence	for those who find eqn of AB first, M0 for just $\frac{y-4}{1-4} = \frac{x-3}{-2-3}$ oe, but M1 for $y-4 = \frac{1-4}{-2-3}(x-3)$ oe ignore their going on to find the eqn of AB after finding grad AB
			using gradient of AB to obtain grad perp bisector	M1	for use of $m_1m_2 = -1$ soi or ft their gradient AB M0 for just $\frac{-5}{3}$ without AB grad found	this second M1 available for starting with given line = $\frac{-5}{3}$ and obtaining grad. of AB from it
			$y - 2.5 = \frac{-5}{3}(x - 0.5)$ oe	M1	eg M1 for $y = \frac{-5}{3}x + c$ and subst of midpt; ft their gradient of perp bisector and midpt; M0 for just rearranging given equation	no ft for gradient of AB used

Question			Answer	Marks	Guidance	
			completion to given answer $3y + 5x = 10$, showing at least one interim step	M1 **[6]**	condone a slight slip if they recover quickly and general steps are correct (eg sometimes a slip in working with the c in $y = \frac{-5}{3}x + c$ - condone $3y = -5x + c$ followed by substitution and consistent working) M0 if clearly 'fudging'	NB answer given; mark process not answer; annotate if full marks not earned eg with a tick for each mark earned scores such as B2M0M0M1M1 are possible after B2, allow full marks for complete method of showing given line has gradient perp to AB (grad AB must be found independently at some stage) and passes through midpt of AB
10	**(ii)**		$3y + 5(4y - 21) = 10$	M1	or other valid strategy for eliminating one variable attempted eg $\frac{-5}{3}x + \frac{10}{3} = \frac{x}{4} + \frac{21}{4}$; condone one error	or eg $20y = 5x + 105$ and subtraction of two eqns attempted no ft from wrong perp bisector eqn, since given allow M1 for candidates who reach $y = 115/23$ and then make a worse attempt, thinking they have gone wrong
			$(-1, 5)$ or $y = 5$, $x = -1$ isw	A2 **[3]**	A1 for each value; if AO allow SC1 for both values correct but unsimplified fractions, eg $\left(\frac{-23}{23}, \frac{115}{23}\right)$	NB M0A0 in this part for finding E using info from (iii) that implies E is midpt of CD

Question			Answer	Marks	Guidance	
10	(iii)		$(x-a)^2+(y-b)^2=r^2$ seen or used	M1	or for $(x+1)^2+(y-5)^2=k$, or ft their E, where $k>0$	
			1^2+4^2 oe (may be unsimplified), from clear use of A or B	M1	for calculating AE or BE or their squares, or for subst coords of A or B into circle eqn to find r or r^2, ft their E;	this M not earned for use of CE or DE or ½ CD NB some cands finding $AB^2 = 34$ then obtaining 17 erroneously so M0
			$(x+1)^2+(y-5)^2=17$	A1	for eqn of circle centre E, through A and B; allow A1 for $r^2=17$ found after $(x+1)^2+(y-5)^2=r^2$ stated and second M1 clearly earned if $(x+1)^2+(y-5)^2=17$ appears without clear evidence of using A or B, allow the first M1 then M0 SC1	SC also earned if circle comes from C or D and E, but may recover and earn the second M1 later by using A or B
			showing midpt of CD = (–1, 5)	M1		
			showing CE or DE = $\sqrt{17}$ oe or showing one of C and D on circle	M1	alt M1 for showing $CD^2 = 68$ oe allow to be earned earlier as an invalid attempt to find r	

Question			Answer	Marks	Guidance	
				[5]	showing that both C and D are on circle and commenting that E is on CD is enough for last M1M1; similarly showing $CD^2 = 68$ and both C and D are on circle oe earns last M1M1	other methods exist, eg: may find eqn of circle with centre E and through C or D and then show that A and B and other of C/D are on this circle – the marks are then earned in a different order; award M1 for first fact shown and then final M1 for completing the argument; if part-marks earned, annotate with a tick for each mark earned beside where earned
11	**(i)**		$\left(x-\frac{5}{2}\right)^2-\frac{1}{4}$ oe	B3	B1 for $a = 5/2$ oe and M1 for 6 – *their* a^2 soi;	condone $\left(x-\frac{5}{2}\right)^2-\frac{1}{4}$ oe = 0 condone omission of index –can earn all marks bod M1 for 6 – 4.25 or 6 – 25/2 etc, if bearing some relation to an attempt at 6 – *their* 2.5^2; M0 for just 1.75 etc without further evidence
			$\left(\frac{5}{2},-\frac{1}{4}\right)$ oe or ft	B1 [4]	accept $x = 2.5$, $y = -0.25$ oe	condone starting again and finding using calculus

Question			Answer	Marks	Guidance	
11	**(ii)**		(2, 0) and (3, 0)	B2	B1 each or B1 for both correct plus an extra or M1 for $(x-2)(x-3)$ or correct use of formula or for $\textit{their } a \pm \sqrt{\textit{their } b}$ ft from (i)	condone not expressed as coordinates, for both x and y values; accept eg in table or marked on graph
			(0, 6)	B1		
			graph of quadratic the correct way up and crossing both axes	B1 **[4]**	ignore label of their tp; condone stopping at y-axis	condone ‘U’ shape or slight curving back in/out; condone some doubling / feathering – deleted work sometimes still shows up in scoris; must not be ruled; condone fairly straight with clear attempt at curve at minimum; be reasonably generous on attempt at symmetry
11	**(iii)**		$x^2 - 5x + 6 = 2 - x$	M1	for attempt to equate or subtract eqns or attempt at rearrangement and elimination of x	accept calculus approach: $y' = 2x - 5$
			$x^2 - 4x + 4$ [= 0]	M1	for rearrangement to zero ft and collection of terms; condone one error; if using completing the square, need to get as far as $(x-k)^2 = c$, with at most one error [$(x-2)^2 = 0$ if correct]	use of $y' = -1$ M1

Question			Answer	Marks	Guidance	
			$x = 2$, [$y = 0$]	A1	condone omission of $y = 0$ since already found in (ii) if they have eliminated x, $y = 0$ is not sufft for A1 – need to get $x = 2$ A0 for $x = 2$ and another root	$x = 2$ A1
			'double root at $x = 2$ so tangent' oe; www;	A1 **[4]**	eg 'only one point of contact, so tangent'; or showing $b^2 - 4ac = 0$, and concluding 'so tangent'; www	tgt is y [– 0] = –(x – 2) and obtaining given line A1
12	**(i)**		f(1) = 1–1 +1 + 9 – 10 [= 0]	B1	allow for correct division of f(x) by (x – 1) showing there is no remainder, or for (x − 1)($x^3 + x + 10$) found, showing it 'works' by multiplying it out	condone $1^4 - 1^3 + 1^2 + 9 - 10$
			attempt at division by (x − 1) as far as $x^4 - x^3$ in working	M1	allow equiv for (x + 2) as far as $x^4 + 2x^3$ in working or for inspection with at least two terms of cubic factor correct	eg for inspection, M1 for two terms right and two wrong
			correctly obtaining $x^3 + x + 10$	A1 **[3]**	or $x^3 - 3x^2 + 7x - 5$	if M0 and this division / factorising is done in part (ii) or (iii), allow SC1 if correct cubic obtained there; attach the relevant part to (i) with a formal chain link if not already seen in the image zone for (i)

Question			Answer	Marks	Guidance	
12	(ii)		[g(–2) =] –8 – 2 + 10 or f(–2) = 16 + 8 + 4 – 18 – 10	M1	[in this scheme g(x) = $x^3 + x + 10$] allow M1 for correct trials with at least two values of x (other than 1) using g(x) or f(x) or $x^3 - 3x^2 + 7x - 5$ (may allow similar correct trials using division or inspection)	eg f(2) = 16 – 8 + 4 + 18 – 10 or 20 f(3) = 81 – 27 + 9 + 27 – 10 or 80 f(0) = – 10 f(–1) = 1 + 1 + 1 – 9 – 10 or –16 No ft from wrong cubic 'factors' from (i)
			$x = -2$ isw	A1	allow these marks if already earned in (i)	
						NB factorising of $x^3 + x + 10$ or $x^3 - 3x^2 + 7x - 5$ in (ii) earns credit for (iii) [annotate with a yellow line in both parts to alert you – the image zone for (iii) includes part (ii)]
				[2]		

Question			Answer	Marks	Guidance	
12	**(iii)**		attempted division of $x^3 + x + 10$ by $(x + 2)$ as far as $x^3 + 2x^2$ in working	M1	or $x^3 - 3x^2 + 7x - 5$ by $(x - 1)$ as far as $x^3 - x^2$ in working or inspection with at least two terms of quadratic factor correct	alt method: allow M1 for attempted division of quartic by $x^2 + x - 2$ as far as $x^4 + x^3 - 2x^2$ in working, or inspection etc
			correctly obtaining $x^2 - 2x + 5$	A1	allow these first 2 marks if this has been done in (ii), even if not used here	
			use of $b^2 - 4ac$ with $x^2 - 2x + 5$	M1	may be in attempt at formula (ignore rest of formula)	or completing square form attempted or attempt at calculus or symmetry to find min pt NB M0 for use of $b^2 - 4ac$ with cubic factor etc
			$b^2 - 4ac = 4 - 20$ [= –16]	A1	may be in formula;	or $(x - 1)^2 + 4$ or min = (1, 4)
			so only two real roots[of f(x)] [and hence no more linear factors]	A1	or no real roots of $x^2 - 2x + 5 = 0$; allow this last mark if clear use of $x^2 - 2x + 5 = 0$, even if error in $b^2 - 4ac$, provided result negative, but no ft from wrong factor	or $(x - 1)^2 + 4$ is always positive so no real roots [of $(x - 1)^2 + 4 = 0$] [and hence no linear factors] or similar conclusion from min pt
				[5]	if last M1 not earned, allow SC1 for stating that the only factors of 5 are 1 and 5 and reasoning eg that $(x - 1)(x - 5)$ and $(x + 1)(x + 5)$ do not give $x^2 - 2x + 5$ [hence $x^2 - 2x + 5$ does not factorise]	

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OCR Report to Centres

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4751 Introduction to Advanced Mathematics

General Comments

Candidates found the paper generally accessible, though quite a number struggled with questions 3, 10(iii) and 12(iii). Where candidates felt familiar with topics there were often good answers to questions; however candidates in general were weak on those that looked a bit different, for instance question 3.

Some ran out of space for 10(iii) and needed to use additional paper, especially if they rearranged their equations to make *y* the subject, necessitating the use of fractions.

Some candidates did not respond to all of question 12, but examiners felt that this was usually because they did not know how to proceed, rather than the problem being an issue of time.

Comments on Individual Questions

Section A

1 The first part was very well answered on the whole, with the majority scoring full marks. Most inverted first and attempted to square second.

In part (ii) again a high proportion of correct answers was seen. Among the common errors were responses from candidates who either thought that $81^{\frac{1}{4}} = \sqrt{3}$ or that they needed to find $\left(\sqrt[3]{81}\right)^4$. Regrettably, the error $3^3 = 9$ was not rare.

2 Whereas the numerical work with indices is good, as evidenced in the high number of correct answers in question 1, the algebraic work is definitely weaker – as was seen in this question. There were still a pleasing number of correct solutions, but quite a few dropped a mark or two here – often for not cubing the 4 in the numerator - and/or for having x^{10} in the denominator.

3 Many candidates did not know where to start. Having picked up on the keyword 'circle' many just wrote down the general equation of a circle and nothing else, or offered no response at all. For some candidates, lack of real understanding of algebra meant that when confronted with a different style of question they were unable to find an appropriate strategy. Some students did not remember the required circle formulae, eg $A = 2\pi r^2$ was not uncommon. Those starting with the given form $Cd = kA$ and putting in the correct formulae were often most successful. The squaring of $\frac{d}{2}$ was often the downfall, many getting $\frac{d^2}{2}$, leading to $k = 2$. Many had several attempts at this question and solutions were often scrappily presented and difficult to follow.

4 A few made basic mistakes in factorising and finding the end-points. Those who sketched the graph of the quadratic usually reached the correct inequality. Some used the quadratic formula, which often led to unsimplified end points. Those who did not sketch often made an error such as '$(5x - 2) \leq 0$ or $(x - 6) \leq 0$' as their next step after factorising. Unusually, some candidates offered final answers such as $-0.4 \leqslant 0 \leqslant 6$.

5 Most candidates were able to make a start and substitute 2 and -3 into $f(x)$, although not all used the information given to write the results as equations. Errors in handling $(-3)^2$ or the 35 were common. Having obtained equations, many did not then go on to use standard methods to solve the simultaneous equations, or made errors in doing so. This meant that the full 4 marks available were given less often than examiners had hoped, although many picked up 2 or 3 marks.

6 A large proportion of candidates did not understand what was meant by 'a term which is constant'. A good number still found the term $20\ 2x^{3}\left(\frac{5}{x}\right)^{3}$ but did not recognise it as the term needed to find the constant. Even those who did know what was meant by a constant term usually wrote out the whole expansion rather than identifying which was the relevant term from the start. Brackets were often missing, leading to incorrect evaluations.

7 Simplifying and adding the surds was done correctly by a high proportion of candidates.

Most candidates knew how to rationalise a denominator for the second part but mistakes in implementation were common, the denominator being more frequently correct than the numerator.

8 A good number were successful in the rearrangement, but some very poor work was also seen, revealing fundamental misconceptions about algebraic manipulation. Common errors included dividing some terms by *a* but not others, and confusion of division and subtraction.

9 Most candidates obtained full marks for sketching the cubic curve, although their cubics were often unshapely, partly due to the incorrect assumption by many that there was a turning point where the graph crossed the y-axis. Most had the cubic the correct way up and realised that it touched the x-axis at -2. A few labelled the y-intersection as 12 rather than -12. A minority sketched parabolas.

Full marks were less common in the second part; a small proportion translated to the right rather than to the left as $f(x + 3)$ required. A larger minority did not know what to do and obtained no marks, often giving the single root $x = -3$.

Section B

10(i) This part was usually done well. Most candidates were confident finding the gradient of AB, although a few failed to show their working. Almost all were then able to find the perpendicular gradient. A minority were unaware that the perpendicular bisector would pass through the midpoint of AB. Most who realised this were able to calculate the midpoint accurately. Once all the information was combined into a straight line equation, a significant minority struggled to rearrange the equation correctly because the arithmetic involved fractions. Pleasingly almost all the candidates managed to work towards the given equation, rather than trying to use the given equation to get back to a common form with their answer. Some wasted time finding the equation of AB first.

(ii) Some wasted time finding the equation of CD, which was given. Many solved the simultaneous equations correctly, but sometimes using less efficient methods, giving themselves complicated fractions to work with. A few who eliminated x struggled with simplifying $y = 115/23$. A significant minority used the implication in part (iii) that E was the midpoint of CD to obtain a solution, gaining no marks for this.

(iii) Most knew the form for the equation of the circle, although some used r or $\sqrt{r}$ instead of r^2. Some used C or D or the length of CD to calculate the radius, instead of using A or B. Others assumed that AB was a diameter. Very few produced enough to show that CD is a diameter, with many thinking that showing that CD is twice the radius was enough. Some stated that E was the midpoint of CD without any working to support it. This meant that the full 5 marks on this question were rarely awarded, though a significant number obtained 4 marks.

11 Overall, this question was well done, with the vast majority of candidates being able to achieve some measure of success.

(i) The majority are quite confident in the technique of completing the square, although some struggled with the arithmetic since fractions were involved. Some candidates did not complete the question and omitted to state the coordinates of the turning point; some others made sign errors such as (−2.5, 0.25) after a correct completion of the square.

(ii) Apart from the occasional upside down parabola and the odd cubic, most candidates made a good attempt at drawing a sketch of the curve, showing the relevant information about the intersections with the axes. They found the required factorisation straightforward, though a few candidates did resort to using the formula and in several of these cases they failed to recognise that $\sqrt{0.25}$ is equal to 0.5. The quality of the curve was often poor, probably because candidates marked the intersections on the axis first and then tried to draw the curve through them, but it was usually good enough to earn the mark.

(iii) A good number found $x = 2$ correctly. Some candidates chose to eliminate x rather than y and more often than not went wrong. Many candidates realised that a repeated root meant that the line was a tangent to the curve, but quite a few clearly did not, with some omitting the final step of showing that the line was a tangent to the curve. A small number of candidates justified the tangent by using calculus in order to determine the slope of the line and the curve at their point of intersection.

12(i) A large number of candidates successfully used the factor theorem to score the first mark and many went on to find the correct cubic factor - the majority of these choosing to do long division rather than use the inspection method. Some did not use the factor theorem but still showed that $x = 1$ was a root by successful division with no remainder. Those who used inspection without first applying the factor theorem did not in general show enough working for a convincing argument that there was no remainder and therefore that $x = 1$ was a root. A small number did not appear to understand what was meant by 'express f(x) as the product of a linear factor and a quadratic factor' - some of these gained partial credit for the correct division seen in parts (ii) or (iii).

(ii) Many used the correct method but made careless errors in calculations especially when trying negative values of x. Very few realised that they could use the factor theorem on the cubic they had found to obtain another root. Many confused 'root' with 'factor' and lost a mark.

(iii) Only about a third of the candidates found the correct quadratic factor. Those who found the quadratic usually gave sensible arguments based on the discriminant to show that only two real roots existed for the quartic. Some tried to use $b^2 - 4ac$ on the cubic $x^3 + x + 10$. Several candidates went back to square one and attempted to factorise the quartic rather than linking the earlier parts to the problem. Some candidates who had not progressed far in the first two parts sometimes made no attempt at this part.