

# Mathematics

Advanced GCE

Unit **4725**: Further Pure Mathematics 1

## Mark Scheme for June 2012

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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.

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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
Dep/D	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
A2	Accuracy mark awarded 2

## Subject-specific Marking Instructions for GCE Mathematics 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 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 assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must be the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the work must 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 methods must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, but is to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) 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. Marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate to state an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of a mark is 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 the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a candidate who 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 indicates otherwise; and similarly where there are several B marks allocated. (The notation 'dep \*' is used to indicate that a part is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate is 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, if 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 in the question. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (acc) is given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage, 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 be given 'through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is in 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 expected standard. 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 be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The mark scheme will detail any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme. 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 mark 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 (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 the same according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is withheld. 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)	$21 + 11i$	B1 B1 [2]	Real part correct Imaginary part correct
1	(ii)	$26 - 29i$ $\frac{26}{41} - \frac{29}{41}i$	M1 A1 A1 [3]	Multiply by conjugate of denominator or find a pair of simultaneous equations Obtain correct numerator or real part Obtain correct denominator or imaginary part
2	(i)	$\begin{pmatrix} 5 & 2 \\ 13 & 6 \end{pmatrix}$	M1 A1 [2]	Multiplication attempt, 2 elements correct All elements correct
2	(ii)	EITHER $\mathbf{B}^{-1}\mathbf{A}^{-1} = (\mathbf{AB})^{-1}$  $\frac{1}{4}\begin{pmatrix} 6 & -2 \\ -13 & 5 \end{pmatrix}$  OR	B1 B1ft B1ft [3] B1 B1 B1	Stated or used Divide by correct determinant Both diagonals correct  Either inverse correct Two elements correct in final answer, both inverses must be correct All elements correct

Question	Answer	Marks	Guidance
3	EITHER $a = -8$ $b = 25$ OR $a = -8$ $b = 25$	M1 A1 M1 A1 [4] M1 M1 A1 A1	Use sum of root and conjugate Obtain correct answer Use product of root and conjugate Obtain correct answer Substitute $4 + 3i$ or conjugate into equation Equate real and imaginary parts Obtain correct answer Obtain correct answer
4	$\frac{1}{2}n(n+1)(2n+1) - \frac{3}{2}n(n+1) + 2n$ $n(n^2 + 1)$	M1 M1 A1 A1 M1 A2 [7]	Express as sum of 3 series Use standard series results, at least 1 correct Two terms correct Third term correct Obtain factor of $n$ Obtain correct answer c.a.o. Allow A1 for $\frac{1}{2(2n^2 + 2)}$
5		B1 M1* DepM1 A1 B1 [5]	Verify result true when $n = 1$ Add next term in series Attempt to obtain $3^{k+1}$ correctly Show sufficient working to justify correct expression Clear statements of Induction processes, but 1 <sup>st</sup> 4 marks must all be earned.

Question		Answer	Marks	Guidance
6	(i)	$5u^2 + 11u + 8 = 0$	M1 M1 A1 [3]	Attempt to clear fractions Attempt to expand and simplify to a quadratic Obtain correct answer, must be an equation
6	(ii)	EITHER $u = \frac{1}{x} - 1$ $\frac{8}{5}$  OR $\frac{1}{\alpha\beta} - \frac{\alpha + \beta}{\alpha\beta} + 1$ $\frac{8}{5}$	B1  M1 A1 FT [3]  B1  M1 A1	State or imply by using roots of new quadratic Use their $c/a$ Obtain correct answer  Express in terms of $\alpha + \beta$ and $\alpha\beta$ Use values $-\frac{1}{2}$ and $\frac{5}{2}$ correctly Obtain correct answer

Must be valid equation

Question		Answer	Marks	Guidance
7	(i)		B1B1 B1ft B1ft B1B1 [6]	Circle, centre ( 3 , 4 ) Touching x-axis, ft for ( <del>3</del> , -4) etc as centre Crossing y-axis twice Horizontal line, y intercept 4
7	(ii)	$-1 + 4i$ $7 + 4i$	B1B1 [2]	State correct answers
7	(iii)		B1ft B1 [2]	Inside circle or above line Completely correct diagram
8	(i)		B1 [1]	Show <b>given</b> answer correctly
8	(ii)	$1 + \frac{1}{2} - \frac{1}{n+1} - \frac{1}{n+2}$	M1 M1 A1 A1 M1 A1 [6]	Express terms as differences using (i) Attempt this for at least first 3 terms First 3 terms all correct Last 2 terms correct Show terms cancelling Obtain correct answer, must be in terms of $n$
8	(iii)	$\frac{3}{2}$  $N = 4$	B1ft  B1 M1 A1 [4]	State or use correct sum to infinity  Their sum to infinity – their (ii) = $\frac{11}{30}$ Attempt to solve correct equation Obtain only $N = 4$

Question		Answer	Marks	Guidance
9	(i)		B1* depB1  [2]	Shear eg image of (0, 1) is (2, 1) or parallel to the x-axis
9	(ii)	<p>Either</p> $\begin{pmatrix} 1 & -2 \\ 0 & 1 \end{pmatrix}$ $\begin{pmatrix} \frac{1}{2} & \frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & \frac{1}{2} \end{pmatrix}$ <p>Or</p> $\mathbf{Z} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} 1 & 2 \\ 0 & 1 \end{pmatrix}$ $\begin{pmatrix} a & 2a+b \\ c & 2c+d \end{pmatrix}$ $\begin{pmatrix} \frac{1}{2} & \frac{\sqrt{3}}{2} \\ -\frac{\sqrt{3}}{2} & \frac{1}{2} \end{pmatrix}$	<p>B1 B1 B1</p> <p>M1 A1</p> <p>[5]</p> <p>B1 B1 B1</p> <p>M1 A1</p>	<p>State <math>\mathbf{Z} = \mathbf{YX}</math> Obtain <math>\mathbf{Y} = \mathbf{ZX}^{-1}</math> State or use correct inverse</p> <p>Matrix multiplication, 2 elements correct Obtain completely correct simplified exact matrix</p> <p>Correct order for matrix multiplication</p> <p>Obtain 2 correct elements Obtain other 2 correct elements</p> <p>Equate elements, 2 correct Obtain completely correct simplified exact matrix</p>
9	(iii)		B1* depB1  [2]	Rotation 60° clockwise

Question			Answer	Marks	Guidance
10	(i)		$a^3 - 4a$	M1 M1 A1 [3]	Show correct expansion process for $3 \times 3$ Correct evaluation of any $2 \times 2$ Obtain correct answer
10	(ii)	(a)		B1 [1]	det $\mathbf{D} = 15$ so unique sol'n or solve to find correct solution $(-2/5, 1, 4/5)$
10	(ii)	(b)		B1 M1 A1 [3]	Their det $\mathbf{D} = 0$ , so non-unique solutions Attempt to solve equations with $a = 2$ Explain inconsistency with correct working
10	(ii)	(c)		B1 M1 A1 [3]	Their det $\mathbf{D} = 0$ , so non-unique solutions Attempt to solve equations with $a = 0$ Explain consistency with correct working

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