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ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
2015

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# Mathematics

Assessment Unit F1

*assessing*

Module FP1: Further Pure Mathematics 1

[AMF11]

WEDNESDAY 24 JUNE, MORNING

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## TIME

1 hour 30 minutes.

## INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number on the Answer Booklet provided.

Answer **all six** questions.

Show clearly the full development of your answers.

Answers should be given to three significant figures unless otherwise stated.

You are permitted to use a graphic or scientific calculator in this paper.

## INFORMATION FOR CANDIDATES

The total mark for this paper is 75

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

A copy of the **Mathematical Formulae and Tables booklet** is provided.

Throughout the paper the logarithmic notation used is  $\ln z$  where it is noted that  $\ln z \equiv \log_e z$

**Answer all six questions.**

**Show clearly the full development of your answers.**

**Answers should be given to three significant figures unless otherwise stated.**

1 Let the matrix  $\mathbf{R} = \begin{pmatrix} 4 & 9 & 0 \\ 0 & -2 & 8 \\ 0 & 0 & 7 \end{pmatrix}$

(i) Calculate  $\mathbf{R} \begin{pmatrix} 3 \\ -2 \\ 0 \end{pmatrix}$  [2]

(ii) Explain fully the relationship between the matrix  $\mathbf{R}$  and  $\begin{pmatrix} 3 \\ -2 \\ 0 \end{pmatrix}$  [2]

(iii) Hence, or otherwise, express  $\mathbf{R}^2 \begin{pmatrix} 3 \\ -2 \\ 0 \end{pmatrix}$  in the form  $\alpha \begin{pmatrix} 3 \\ -2 \\ 0 \end{pmatrix}$ , where  $\alpha$  is an integer. [4]

2 A circle has equation

$$x^2 + y^2 - 4x - 8y + 10 = 0$$

(i) Find the equation of the tangent to the circle at the point  $(-1, 5)$ . [5]

(ii) Find the equation of the other tangent to this circle that is parallel to the tangent found in (i). [5]

3 The matrix  $\mathbf{M}$  is given by

$$\mathbf{M} = \begin{pmatrix} a & 1 & -2 \\ 1 & 4 & 1 \\ -2 & 1 & a \end{pmatrix}$$

Consider the matrix equation

$$\mathbf{M} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} b \\ 2 \\ 5 \end{pmatrix}$$

(i) Find the values of  $a$  for which the matrix equation does not have a unique solution. [5]

(ii) If  $a = -2$  and  $b = 6$  explain why the matrix equation has no solution. [3]

(iii) If  $a = -2$  and  $b = 5$  find the general solution of the matrix equation. [4]

4 S is the set of matrices  $\begin{pmatrix} r & s \\ s & r \end{pmatrix}$ , where  $r, s$  are real numbers such that  $r^2 \neq s^2$

Prove that S forms a group under matrix multiplication.

You may assume that matrix multiplication is associative. [12]

5 (a) Write down the matrix which represents a rotation of  $45^\circ$  anticlockwise about the origin. [2]

(b) The matrix  $\mathbf{N} = \begin{pmatrix} 2 & 1 \\ -6 & 3 \end{pmatrix}$

Under the transformation represented by  $\mathbf{N}$  the line  $y = mx$  is reflected in the  $y$ -axis.

Find the possible values of  $m$ . [8]

6 (a) (i) Given that

$$(a + bi)^2 = -5 + 12i$$

find the real values of  $a$  and the corresponding values of  $b$ . [8]

(ii) Hence find the complex roots of the quadratic equation

$$z^2 - (4 - i)z + (5 - 5i) = 0$$
 [6]

(b) (i) Sketch on an Argand diagram the locus of those points  $w$  which satisfy

$$|w - (3 + 3i)| = \frac{3}{\sqrt{2}}$$
 [3]

(ii) For any point  $w$  on the locus described in (b)(i), show that

$$\frac{\pi}{12} \leq \arg w \leq \frac{5\pi}{12}$$

A solution by scale drawing will not be accepted. [6]

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**THIS IS THE END OF THE QUESTION PAPER**

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