



Rewarding Learning

ADVANCED
General Certificate of Education
2013

Mathematics

Assessment Unit F3

assessing

Module FP3: Further Pure Mathematics 3

[AMF31]

FRIDAY 24 MAY, MORNING



TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number on the Answer Booklet provided.
Answer **all seven** 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 seven questions

Show clearly the full development of your answers.

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

- 1 Find in Cartesian form an equation of the line of intersection of the planes

$$2x + 3y + z = 19$$

$$\text{and } \mathbf{r} \cdot \begin{pmatrix} 3 \\ 2 \\ -6 \end{pmatrix} = 16 \quad [6]$$

- 2 Differentiate

$$\tan^{-1}\left(\frac{x}{\sqrt{4-x^2}}\right) + \cos^{-1}\left(\frac{x}{2}\right)$$

simplifying your answer as far as possible. [9]

- 3 Find

$$\int \frac{3 - 5y^3}{\sqrt{1 - y^2}} dy$$

[5]

- 4 (i) Using the exponential definitions of $\cosh x$ and $\sinh x$, prove the identity

$$e^{nx} \equiv (\cosh x + \sinh x)^n \quad [2]$$

- (ii) Using part (i) and the corresponding identity

$$e^{-nx} \equiv (\cosh x - \sinh x)^n$$

prove that

$$\sinh 3x \equiv 4 \sinh^3 x + 3 \sinh x \quad [6]$$

- 5 (i) Use the exponential definition of $\sinh x$ to show that

$$\sinh^{-1}(x) \equiv \ln(x + \sqrt{x^2 + 1}) \quad [4]$$

- (ii) Hence show that

$$\frac{d}{dx}(x \sinh^{-1}(x)) = \sinh^{-1}x + \frac{x}{\sqrt{x^2 + 1}} \quad [6]$$

- (iii) Hence, or otherwise, show that

$$\int_0^{\frac{4}{3}} \ln(x + \sqrt{x^2 + 1}) dx = \frac{2}{3}(2 \ln 3 - 1) \quad [7]$$

- 6 The Kiltough Jewel can be modelled by the irregular tetrahedron PQRS shown in Fig. 1 below.

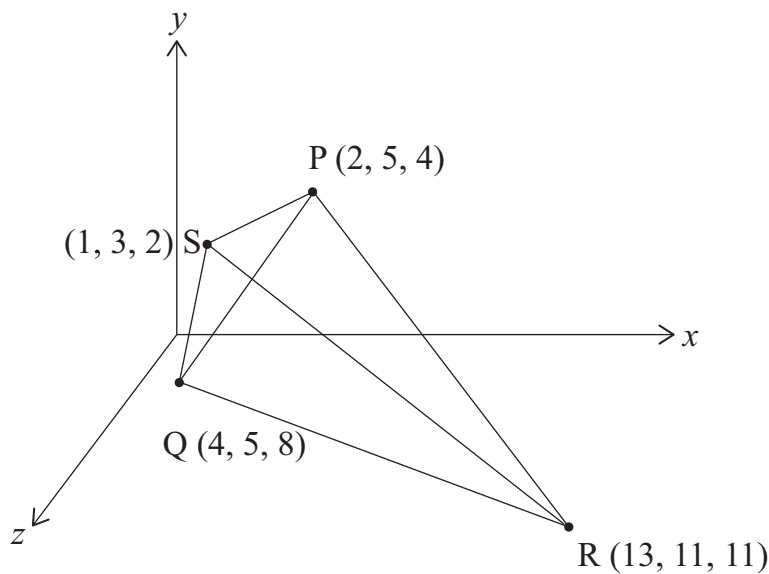


Fig. 1

- (i) Derive a Cartesian equation of the plane SPQ. [7]

- (ii) Using a formula of the form

$$V = \frac{1}{6} |\mathbf{a} \cdot \mathbf{b} \times \mathbf{c}|$$

find the volume of the jewel. [4]

- (iii) Calculate the angle between the edge SR and the face SPQ. [5]

7 (i) Differentiate

$$(1 - x^2)^{\frac{3}{2}} \quad [2]$$

(ii) Hence show that if

$$I_n = \int_0^1 x^n \sqrt{1 - x^2} \, dx$$

for each non-negative integer n , then

$$I_n = \frac{n-1}{n+2} I_{n-2} \quad n \geq 2 \quad [8]$$

(iii) Show that

$$\int_0^1 x^5 \sqrt{1 - x^2} \, dx = \frac{8}{105} \quad [4]$$

THIS IS THE END OF THE QUESTION PAPER
