

**Thursday 13 June 2013 – Morning**

**A2 GCE MATHEMATICS (MEI)**

**4754/01A** Applications of Advanced Mathematics (C4) Paper A

**QUESTION PAPER**

Candidates answer on the Printed Answer Book.

**OCR supplied materials:**

- Printed Answer Book 4754/01A
- MEI Examination Formulae and Tables (MF2)

**Other materials required:**

- Scientific or graphical calculator

**Duration:** 1 hour 30 minutes



**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 permitted to use a scientific or graphical 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 **16** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.
- This paper will be followed by **Paper B: Comprehension**.

**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.

## Section A (36 marks)

1 (i) Express  $\frac{x}{(1+x)(1-2x)}$  in partial fractions. [3]

(ii) Hence use binomial expansions to show that  $\frac{x}{(1+x)(1-2x)} = ax + bx^2 + \dots$ , where  $a$  and  $b$  are constants to be determined.

State the set of values of  $x$  for which the expansion is valid. [5]

2 Show that the equation  $\operatorname{cosec} x + 5 \cot x = 3 \sin x$  may be rearranged as

$$3 \cos^2 x + 5 \cos x - 2 = 0.$$

Hence solve the equation for  $0^\circ \leq x \leq 360^\circ$ , giving your answers to 1 decimal place. [7]

3 Using appropriate right-angled triangles, show that  $\tan 45^\circ = 1$  and  $\tan 30^\circ = \frac{1}{\sqrt{3}}$ .

Hence show that  $\tan 75^\circ = 2 + \sqrt{3}$ . [7]

4 (i) Find a vector equation of the line  $l$  joining the points  $(0, 1, 3)$  and  $(-2, 2, 5)$ . [2]

(ii) Find the point of intersection of the line  $l$  with the plane  $x + 3y + 2z = 4$ . [3]

(iii) Find the acute angle between the line  $l$  and the normal to the plane. [3]

5 The points A, B and C have coordinates  $A(3, 2, -1)$ ,  $B(-1, 1, 2)$  and  $C(10, 5, -5)$ , relative to the origin O. Show that  $\overrightarrow{OC}$  can be written in the form  $\lambda \overrightarrow{OA} + \mu \overrightarrow{OB}$ , where  $\lambda$  and  $\mu$  are to be determined.

What can you deduce about the points O, A, B and C from the fact that  $\overrightarrow{OC}$  can be expressed as a combination of  $\overrightarrow{OA}$  and  $\overrightarrow{OB}$ ? [6]

## Section B (36 marks)

- 6 The motion of a particle is modelled by the differential equation

$$v \frac{dv}{dx} + 4x = 0,$$

where  $x$  is its displacement from a fixed point, and  $v$  is its velocity.

Initially  $x = 1$  and  $v = 4$ .

- (i) Solve the differential equation to show that  $v^2 = 20 - 4x^2$ . [4]

Now consider motion for which  $x = \cos 2t + 2 \sin 2t$ , where  $x$  is the displacement from a fixed point at time  $t$ .

- (ii) Verify that, when  $t = 0$ ,  $x = 1$ . Use the fact that  $v = \frac{dx}{dt}$  to verify that when  $t = 0$ ,  $v = 4$ . [4]

- (iii) Express  $x$  in the form  $R \cos(2t - \alpha)$ , where  $R$  and  $\alpha$  are constants to be determined, and obtain the corresponding expression for  $v$ . Hence or otherwise verify that, for this motion too,  $v^2 = 20 - 4x^2$ . [7]

- (iv) Use your answers to part (iii) to find the maximum value of  $x$ , and the earliest time at which  $x$  reaches this maximum value. [3]

- 7 Fig. 7 shows the curve BC defined by the parametric equations

$$x = 5 \ln u, \quad y = u + \frac{1}{u}, \quad 1 \leq u \leq 10.$$

The point A lies on the  $x$ -axis and AC is parallel to the  $y$ -axis. The tangent to the curve at C makes an angle  $\theta$  with AC, as shown.

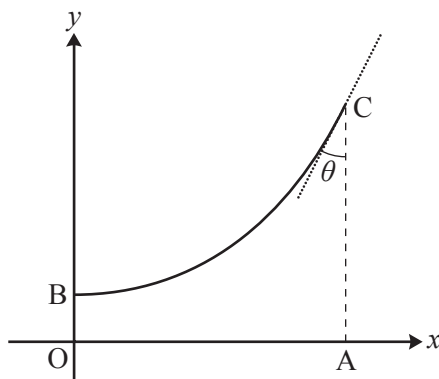


Fig. 7

- (i) Find the lengths OA, OB and AC. [5]
- (ii) Find  $\frac{dy}{dx}$  in terms of  $u$ . Hence find the angle  $\theta$ . [6]
- (iii) Show that the cartesian equation of the curve is  $y = e^{\frac{1}{5}x} + e^{-\frac{1}{5}x}$ . [2]

An object is formed by rotating the region OACB through  $360^\circ$  about Ox.

- (iv) Find the volume of the object. [5]

**THERE ARE NO QUESTIONS WRITTEN ON THIS PAGE.**



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**Thursday 13 June 2013 – Morning**

**A2 GCE MATHEMATICS (MEI)**

**4754/01B** Applications of Advanced Mathematics (C4) Paper B: Comprehension  
**QUESTION PAPER**

Candidates answer on the Question Paper.

**OCR supplied materials:**

- Insert (inserted)
- MEI Examination Formulae and Tables (MF2)

**Other materials required:**

- Scientific or graphical calculator
- Rough paper

**Duration:** Up to 1 hour



Candidate forename		Candidate surname	
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Centre number						Candidate number				
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**INSTRUCTIONS TO CANDIDATES**

- The Insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.
- The Insert contains the text for use with the questions.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

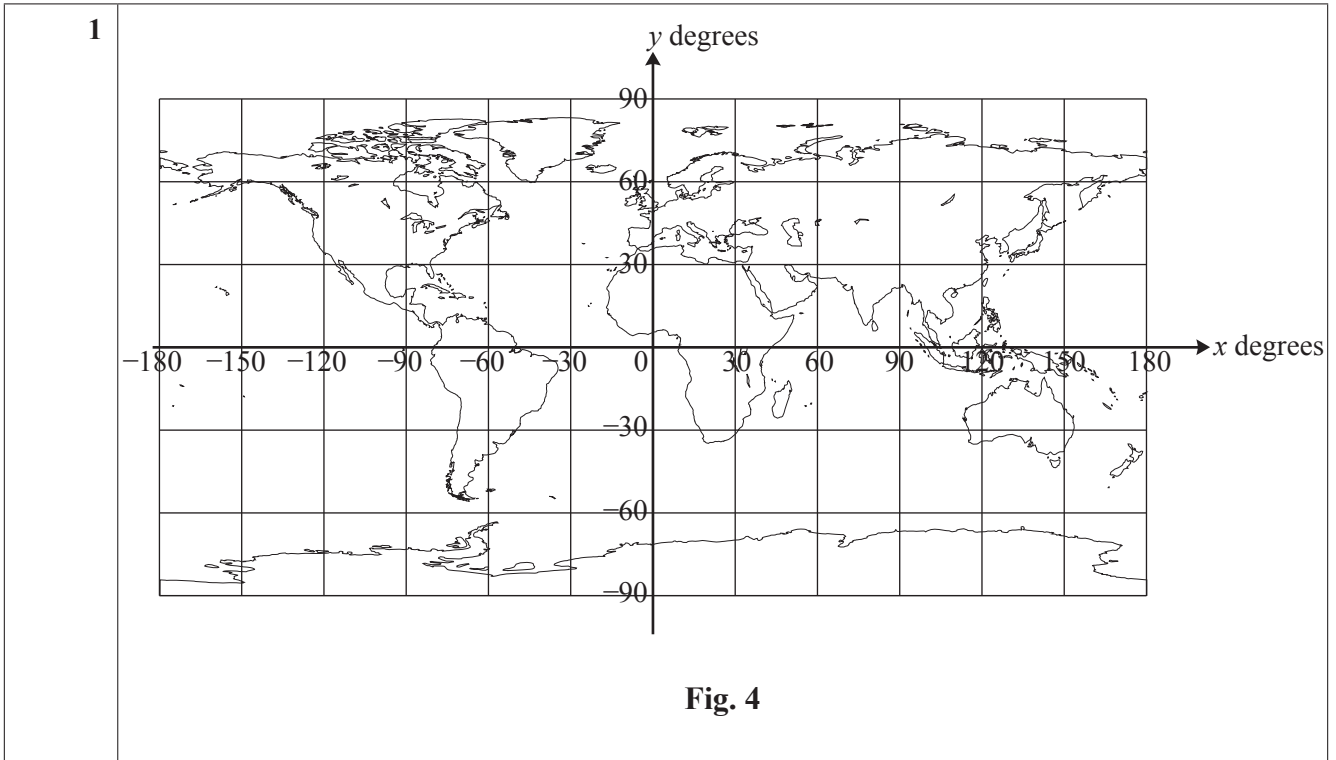
**INFORMATION FOR CANDIDATES**

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You may find it helpful to make notes and to do some calculations as you read the passage.
- You are **not** required to hand in these notes with your 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 **18**.
- This document consists of **8** pages. Any blank pages are indicated.

1 The diagram is a copy of Fig. 4.

R is a place with latitude  $45^\circ$  north and longitude  $60^\circ$  west. Show the position of R on the diagram.

M is the sub-solar point. It is on the Greenwich meridian and the declination of the sun is  $+20^\circ$ . Show the position of M on the diagram. [2]



2 Use Fig. 8 to estimate the difference in the length of daylight between places with latitudes of  $30^\circ$  south and  $60^\circ$  south on the day for which the graph applies. [3]

<b>2</b>	
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3 The graph is a copy of Fig. 6.

The article says that it shows the terminator in the cases where the sun has declination  $10^\circ$  north,  $1^\circ$  north,  $5^\circ$  south and  $15^\circ$  south.

Identify which curve (A, B, C or D) relates to which declination.

[2]

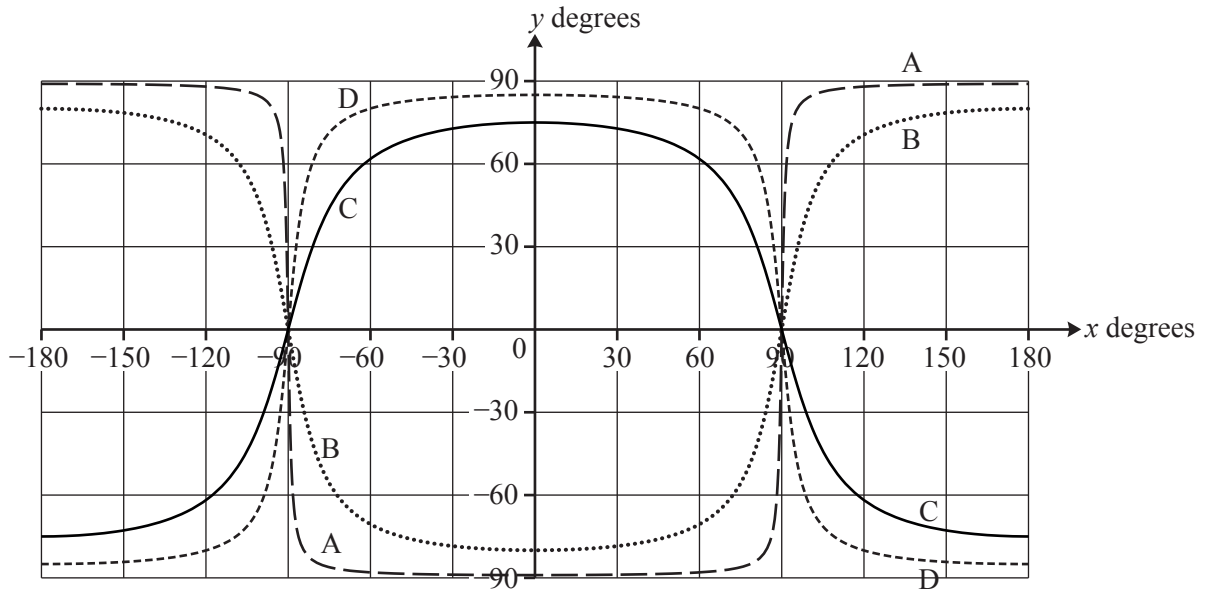


Fig. 6

<b>3</b>	10° north:
	1° north:
	5° south:
	15° south:

4 In lines 94 and 95 the article says

“Fig. 8 shows you that at latitude  $60^\circ$  north the terminator passes approximately through time +9 hours and -9 hours so that there are about 18 hours of daylight.”

Use Equation (4) to check the accuracy of the figure of 18 hours.

[4]

4	



5 (i) Use Equation (3) to calculate the declination of the sun on February 2nd. [3]

(ii) The town of Boston, in Lincolnshire, has latitude  $53^\circ$  north and longitude  $0^\circ$ .

Calculate the time of sunset in Boston on February 2nd.

Give your answer in hours and minutes using the 24-hour clock. [4]

5 (i)	
5 (ii)	

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