Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

General Certificate of Education
Advanced Level Examination
January 2012

Mathematics MPC3

Unit Pure Core 3

Friday 20 January 2012 1.30 pm to 3.00 pm

For this paper you must have:
- the blue AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

Time allowed
- 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- You must answer the questions in the spaces provided. Do not write outside the box around each page.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

Advice
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- You do not necessarily need to use all the space provided.

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Answer **all** questions in the spaces provided.

1 (a) Use Simpson's rule with 7 ordinates (6 strips) to find an estimate for $\int_0^3 4^x \, dx$.

(4 marks)

(b) A curve is defined by the equation $y = 4^x$. The curve intersects the line $y = 8 - 2x$ at a single point where $x = \alpha$.

(i) Show that α lies between 1.2 and 1.3. *(2 marks)*

(ii) The equation $4^x = 8 - 2x$ can be rearranged into the form $x = \dfrac{\ln(8 - 2x)}{\ln 4}$.

Use the iterative formula $x_{n+1} = \dfrac{\ln(8 - 2x_n)}{\ln 4}$ with $x_1 = 1.2$ to find the values of x_2 and x_3, giving your answers to three decimal places. *(2 marks)*

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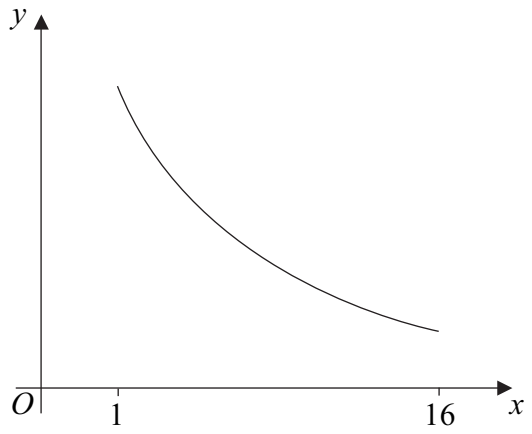
2 The curve with equation $y = \dfrac{63}{4x - 1}$ is sketched below for $1 \leqslant x \leqslant 16$.



The function f is defined by $\mathrm{f}(x) = \dfrac{63}{4x - 1}$ for $1 \leqslant x \leqslant 16$.

(a) Find the range of f. *(2 marks)*

(b) The inverse of f is f^{-1}.

(i) Find $\mathrm{f}^{-1}(x)$. *(3 marks)*

(ii) Solve the equation $\mathrm{f}^{-1}(x) = 1$. *(2 marks)*

(c) The function g is defined by $\mathrm{g}(x) = x^2$ for $-4 \leqslant x \leqslant -1$.

(i) Write down an expression for $\mathrm{fg}(x)$. *(1 mark)*

(ii) Solve the equation $\mathrm{fg}(x) = 1$. *(3 marks)*

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3 (a) Given that $y = 4x^3 - 6x + 1$, find $\frac{dy}{dx}$. *(1 mark)*

(b) Hence find $\int_2^3 \frac{2x^2 - 1}{4x^3 - 6x + 1}\,dx$, giving your answer in the form $p \ln q$, where p and q are rational numbers. *(5 marks)*

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4 (a) By using a suitable trigonometrical identity, solve the equation

$$\tan^2\theta = 3(3 - \sec\theta)$$

giving all solutions to the nearest $0.1°$ in the interval $0° < \theta < 360°$. *(6 marks)*

(b) Hence solve the equation

$$\tan^2(4x - 10°) = 3[3 - \sec(4x - 10°)]$$

giving all solutions to the nearest $0.1°$ in the interval $0° < x < 90°$. *(3 marks)*

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5 (a) Describe a sequence of two geometrical transformations that maps the graph of $y = \ln x$ onto the graph of $y = 4\ln(x - \mathrm{e})$. *(4 marks)*

(b) Sketch, on the axes given below, the graph of $y = |4\ln(x - \mathrm{e})|$, indicating the exact value of the x-coordinate where the curve meets the x-axis. *(3 marks)*

(c) (i) Solve the equation $|4\ln(x - \mathrm{e})| = 4$. *(3 marks)*

(ii) Hence, or otherwise, solve the inequality $|4\ln(x - \mathrm{e})| \geqslant 4$. *(3 marks)*

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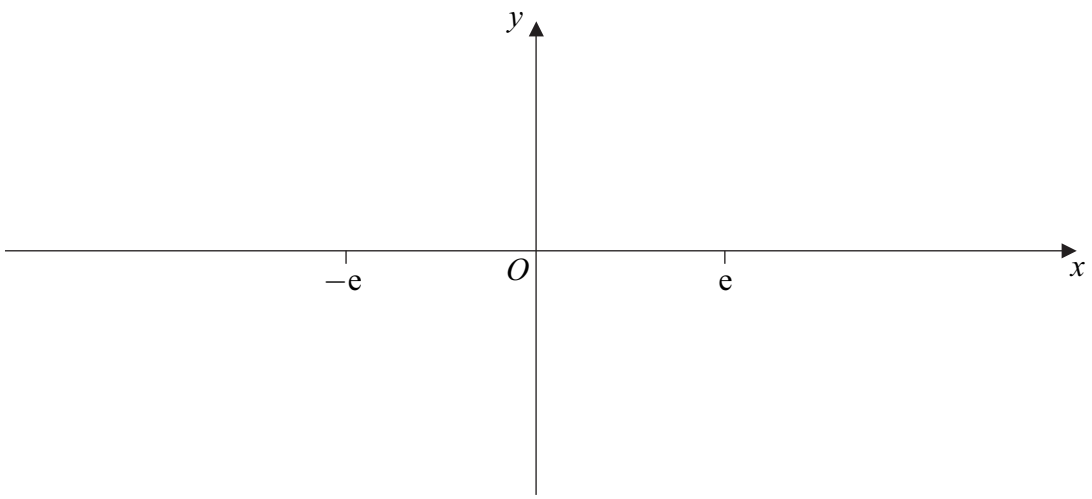
(b)



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6 (a) Given that $x = \dfrac{1}{\sin\theta}$, use the quotient rule to show that $\dfrac{dx}{d\theta} = -\operatorname{cosec}\theta\cot\theta$.

(3 marks)

(b) Use the substitution $x = \operatorname{cosec}\theta$ to find $\displaystyle\int_{\sqrt{2}}^{2} \frac{1}{x^2\sqrt{x^2-1}}\,dx$, giving your answer to three significant figures.

(9 marks)

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7 (a) A curve has equation $y = x^2 e^{-\frac{x}{4}}$.

Show that the curve has exactly two stationary points and find the exact values of their coordinates. *(7 marks)*

(b) (i) Use integration by parts twice to find the exact value of $\int_0^4 x^2 e^{-\frac{x}{4}} \, dx$. *(7 marks)*

(ii) The region bounded by the curve $y = 3xe^{-\frac{x}{8}}$, the x-axis from 0 to 4 and the line $x = 4$ is rotated through 360° about the x-axis to form a solid.

Use your answer to part **(b)(i)** to find the exact value of the volume of the solid generated. *(2 marks)*

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