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**Pearson Edexcel**
**International Advanced Level**

| Centre Number | Candidate Number |
|---|---|
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# Core Mathematics C34

## Advanced

Tuesday 19 January 2016 – Morning
**Time: 2 hours 30 minutes**

Paper Reference
**WMA02/01**

**You must have:**
Mathematical Formulae and Statistical Tables (Blue)

Total Marks

**Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.**

## Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- When a calculator is used, the answer should be given to an appropriate degree of accuracy.

## Information

- The total mark for this paper is 125.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

## Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶





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**1.** $$f(x) = (3 - 2x)^{-4}, \qquad |x| < \frac{3}{2}$$

Find the binomial expansion of $f(x)$, in ascending powers of $x$, up to and including the term in $x^2$, giving each coefficient as a simplified fraction.

**(4)**

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**2.** (a) Show that

$$\cot^2 x - \operatorname{cosec} x - 11 = 0$$

may be expressed in the form $\operatorname{cosec}^2 x - \operatorname{cosec} x + k = 0$, where $k$ is a constant.

**(1)**

(b) Hence solve for $0 \leqslant x < 360°$

$$\cot^2 x - \operatorname{cosec} x - 11 = 0$$

Give each solution in degrees to one decimal place.

(*Solutions based entirely on graphical or numerical methods are not acceptable.*)

**(5)**

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**3.** A curve $C$ has equation

$$3^x + 6y = \frac{3}{2}xy^2$$

Find the exact value of $\frac{\mathrm{d}y}{\mathrm{d}x}$ at the point on $C$ with coordinates (2, 3). Give your answer in the form $\frac{a + \ln b}{8}$, where $a$ and $b$ are integers.

**(7)**

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**4.**

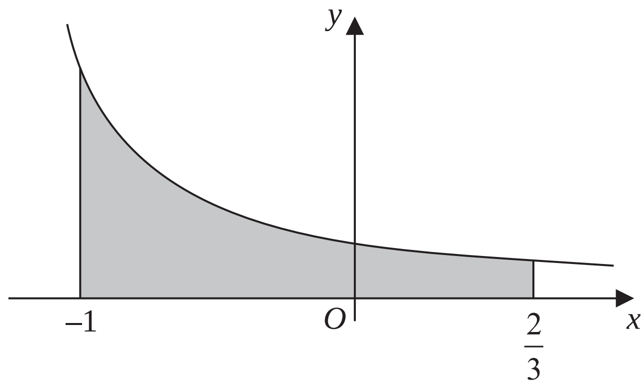


**Figure 1**

The curve $C$ with equation $y = \dfrac{2}{(4 + 3x)}, \; x > -\dfrac{4}{3}$ is shown in Figure 1

The region bounded by the curve, the $x$-axis and the lines $x = -1$ and $x = \dfrac{2}{3}$, is shown shaded in Figure 1

This region is rotated through 360 degrees about the $x$-axis.

(a) Use calculus to find the exact value of the volume of the solid generated.

**(5)**

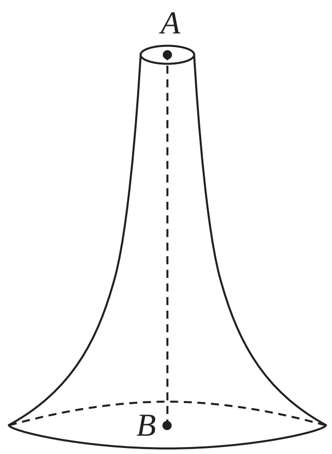


**Figure 2**

Figure 2 shows a candle with axis of symmetry $AB$ where $AB = 15$ cm. $A$ is a point at the centre of the top surface of the candle and $B$ is a point at the centre of the base of the candle. The candle is geometrically similar to the solid generated in part (a).

(b) Find the volume of this candle.

**(2)**

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**Question 4 continued**

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**5.**

$$f(x) = -x^3 + 4x^2 - 6$$

(a) Show that the equation $f(x) = 0$ has a root between $x = 1$ and $x = 2$

**(2)**

(b) Show that the equation $f(x) = 0$ can be rewritten as

$$x = \sqrt{\left(\frac{6}{4 - x}\right)}$$

**(2)**

(c) Starting with $x_1 = 1.5$ use the iteration $x_{n+1} = \sqrt{\left(\frac{6}{4 - x_n}\right)}$ to calculate the values of $x_2$, $x_3$ and $x_4$ giving all your answers to 4 decimal places.

**(3)**

(d) Using a suitable interval, show that 1.572 is a root of $f(x) = 0$ correct to 3 decimal places.

**(2)**

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**Question 5 continued**

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**6.** A hot piece of metal is dropped into a cool liquid. As the metal cools, its temperature $T$ degrees Celsius, $t$ minutes after it enters the liquid, is modelled by

$$T = 300e^{-0.04t} + 20, \quad t \geqslant 0$$

(a) Find the temperature of the piece of metal as it enters the liquid.
**(1)**

(b) Find the value of $t$ for which $T = 180$, giving your answer to 3 significant figures.

(*Solutions based entirely on graphical or numerical methods are not acceptable.*)
**(4)**

(c) Show, by differentiation, that the rate, in degrees Celsius per minute, at which the temperature of the metal is changing, is given by the expression

$$\frac{20 - T}{25}$$

**(3)**

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**7.**

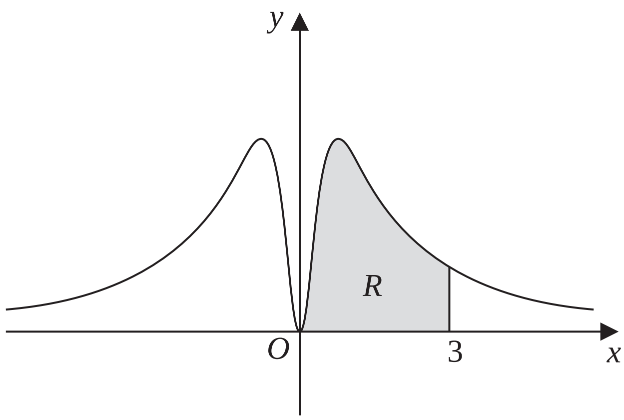


**Figure 3**

Figure 3 shows part of the curve $C$ with equation

$$y = \frac{3\ln(x^2+1)}{(x^2+1)}, \quad x \in \mathbb{R}$$

(a) Find $\dfrac{\mathrm{d}y}{\mathrm{d}x}$

**(2)**

(b) Using your answer to (a), find the exact coordinates of the stationary point on the curve $C$ for which $x > 0$. Write each coordinate in its simplest form.

**(5)**

The finite region $R$, shown shaded in Figure 3, is bounded by the curve $C$, the $x$-axis and the line $x = 3$

(c) Complete the table below with the value of $y$ corresponding to $x = 1$

| $x$ | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| $y$ | 0 | | $\frac{3}{5}\ln 5$ | $\frac{3}{10}\ln 10$ |

**(1)**

(d) Use the trapezium rule with all the $y$ values in the completed table to find an approximate value for the area of $R$, giving your answer to 4 significant figures.

**(3)**

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**Question 7 continued**

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**8.**

$$f(\theta) = 9\cos^2\theta + \sin^2\theta$$

(a) Show that $f(\theta) = a + b\cos 2\theta$, where $a$ and $b$ are integers which should be found.

**(3)**

(b) Using your answer to part (a) and integration by parts, find the exact value of

$$\int_0^{\frac{\pi}{2}} \theta^2 f(\theta)\,d\theta$$

**(6)**

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**9.** (a) Express $\dfrac{3x^2 - 4}{x^2(3x - 2)}$ in partial fractions.

**(4)**

(b) Given that $x > \dfrac{2}{3}$, find the general solution of the differential equation

$$x^2(3x - 2)\,\frac{dy}{dx} = y(3x^2 - 4)$$

Give your answer in the form $y = f(x)$.

**(6)**

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**10.** (a) Express $3\sin 2x + 5\cos 2x$ in the form $R\sin(2x + \alpha)$, where $R > 0$ and $0 < \alpha < \frac{\pi}{2}$

Give the exact value of $R$ and give the value of $\alpha$ to 3 significant figures.

**(3)**

(b) Solve, for $0 < x < \pi$,

$$3\sin 2x + 5\cos 2x = 4$$

(*Solutions based entirely on graphical or numerical methods are not acceptable.*)

**(5)**

$$g(x) = 4(3\sin 2x + 5\cos 2x)^2 + 3$$

(c) Using your answer to part (a) and showing your working,

(i) find the greatest value of $g(x)$,

(ii) find the least value of $g(x)$.

**(4)**

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**Question 10 continued**

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**11.**

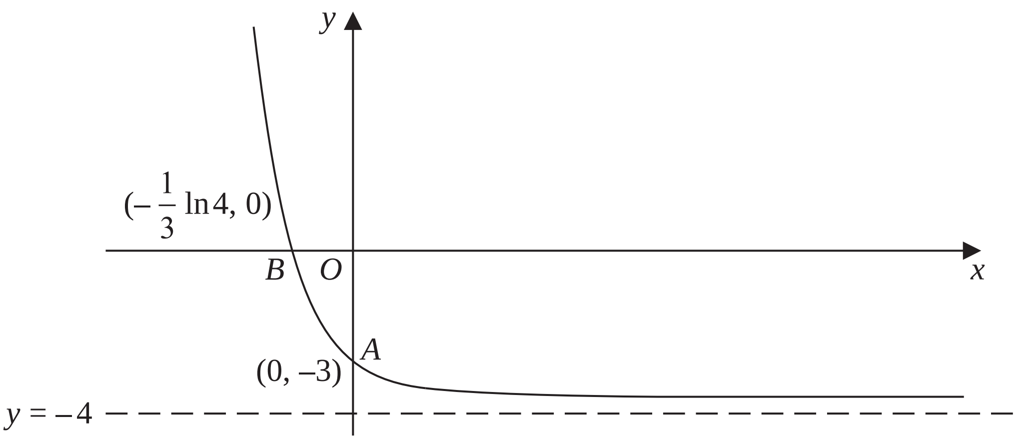


**Figure 4**

Figure 4 shows a sketch of part of the curve with equation $y = \mathrm{f}(x)$, $x \in \mathbb{R}$

The curve meets the coordinate axes at the points $A(0, -3)$ and $B(-\frac{1}{3}\ln 4, 0)$ and the curve has an asymptote with equation $y = -4$

In separate diagrams, sketch the graph with equation

(a) $y = |\mathrm{f}(x)|$ **(4)**

(b) $y = 2\mathrm{f}(x) + 6$ **(3)**

On each sketch, give the exact coordinates of the points where the curve crosses or meets the coordinate axes and the equation of any asymptote.

Given that

$$\mathrm{f}(x) = \mathrm{e}^{-3x} - 4, \qquad x \in \mathbb{R}$$

$$\mathrm{g}(x) = \ln\left(\frac{1}{x+2}\right), \qquad x > -2$$

(c) state the range of f, **(1)**

(d) find $\mathrm{f}^{-1}(x)$, **(3)**

(e) express $\mathrm{fg}(x)$ as a polynomial in $x$. **(3)**

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**Question 11 continued**

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**Question 11 continued**

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**12.** With respect to a fixed origin $O$, the lines $l_1$ and $l_2$ are given by the equations

$$l_1 : \mathbf{r} = \begin{pmatrix} 12 \\ -4 \\ 5 \end{pmatrix} + \lambda \begin{pmatrix} 5 \\ -4 \\ 2 \end{pmatrix}, \qquad l_2 : \mathbf{r} = \begin{pmatrix} 2 \\ 2 \\ 0 \end{pmatrix} + \mu \begin{pmatrix} 0 \\ 6 \\ 3 \end{pmatrix}$$

where $\lambda$ and $\mu$ are scalar parameters.

(a) Show that $l_1$ and $l_2$ meet, and find the position vector of their point of intersection $A$.
**(6)**

(b) Find, to the nearest 0.1°, the acute angle between $l_1$ and $l_2$
**(3)**

The point $B$ has position vector $\begin{pmatrix} 7 \\ 0 \\ 3 \end{pmatrix}$.

(c) Show that $B$ lies on $l_1$
**(1)**

(d) Find the shortest distance from $B$ to the line $l_2$, giving your answer to 3 significant figures.
**(4)**

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**Question 12 continued**

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**13.** A curve $C$ has parametric equations

$$x = 6\cos 2t, \qquad y = 2\sin t, \qquad -\frac{\pi}{2} < t < \frac{\pi}{2}$$

(a) Show that $\dfrac{dy}{dx} = \lambda \operatorname{cosec} t$, giving the exact value of the constant $\lambda$.
**(4)**

(b) Find an equation of the normal to $C$ at the point where $t = \dfrac{\pi}{3}$

Give your answer in the form $y = mx + c$, where $m$ and $c$ are simplified surds.
**(6)**

The cartesian equation for the curve $C$ can be written in the form

$$x = f(y), \qquad -k < y < k$$

where $f(y)$ is a polynomial in $y$ and $k$ is a constant.

(c) Find $f(y)$.
**(3)**

(d) State the value of $k$.
**(1)**

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**Question 13 continued**

Q13

**(Total 14 marks)**

**TOTAL FOR PAPER: 125 MARKS**

**END**