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

Centre Number

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# Core Mathematics C34

## Advanced

Tuesday 21 June 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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Question 1 continued

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Question 1 continued

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Q1

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3. (a) Find the binomial expansion of

$$(1 + ax)^{-3}, \quad |ax| < 1$$

in ascending powers of  $x$ , up to and including the term in  $x^3$ , giving each coefficient as simply as possible in terms of the constant  $a$ .

(3)

$$f(x) = \frac{2 + 3x}{(1 + ax)^3}, \quad |ax| < 1$$

In the series expansion of  $f(x)$ , the coefficient of  $x^2$  is 3

Given that  $a < 0$

(b) find the value of the constant  $a$ ,

(4)

(c) find the coefficient of  $x^3$  in the series expansion of  $f(x)$ , giving your answer as a simplified fraction.

(2)

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Question 3 continued

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4. 
$$g(x) = \frac{x^4 + x^3 - 7x^2 + 8x - 48}{x^2 + x - 12}, \quad x > 3, \quad x \in \mathbb{R}$$

(a) Given that

$$\frac{x^4 + x^3 - 7x^2 + 8x - 48}{x^2 + x - 12} \equiv x^2 + A + \frac{B}{x - 3}$$

find the values of the constants  $A$  and  $B$ .

(4)

(b) Hence, or otherwise, find the equation of the tangent to the curve with equation  $y = g(x)$  at the point where  $x = 4$ . Give your answer in the form  $y = mx + c$ , where  $m$  and  $c$  are constants to be determined.

(5)

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(Total 9 marks)



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Question 6 continued

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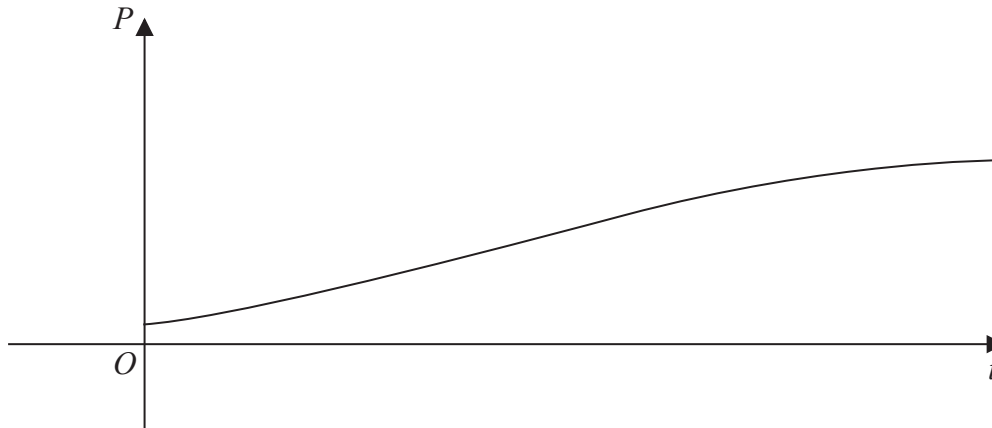


Figure 2

The population of a species of animal is being studied. The population  $P$ , at time  $t$  years from the start of the study, is assumed to be

$$P = \frac{9000e^{kt}}{3e^{kt} + 7}, \quad t \geq 0$$

where  $k$  is a positive constant.

A sketch of the graph of  $P$  against  $t$  is shown in Figure 2.

Use the given equation to

(a) find the population at the start of the study, (2)

(b) find the value for the upper limit of the population. (1)

Given that  $P = 2500$  when  $t = 4$

(c) calculate the value of  $k$ , giving your answer to 3 decimal places. (5)

Using this value for  $k$ ,

(d) find, using  $\frac{dP}{dt}$ , the rate at which the population is increasing when  $t = 10$

Give your answer to the nearest integer. (3)

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Question 9 continued

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Question 9 continued

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Question 9 continued

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(Total 11 marks)

Q9



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10. (a) Given that  $-\frac{\pi}{2} < g(x) < \frac{\pi}{2}$ , sketch the graph of  $y = g(x)$  where

$$g(x) = \arctan x, \quad x \in \mathbb{R}$$

(2)

(b) Find the exact value of  $x$  for which

$$3g(x+1) - \pi = 0$$

(3)

The equation  $\arctan x - 4 + \frac{1}{2}x = 0$  has a positive root at  $x = \alpha$  radians.

(c) Show that  $5 < \alpha < 6$

(2)

The iteration formula

$$x_{n+1} = 8 - 2 \arctan x_n$$

can be used to find an approximation for  $\alpha$

(d) Taking  $x_0 = 5$ , use this formula to find  $x_1$  and  $x_2$ , giving each answer to 3 decimal places.

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Question 10 continued

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

$$l_1 : \mathbf{r} = \begin{pmatrix} 7 \\ 4 \\ 9 \end{pmatrix} + \lambda \begin{pmatrix} 1 \\ 1 \\ 4 \end{pmatrix}$$

$$l_2 : \mathbf{r} = \begin{pmatrix} -6 \\ -7 \\ 3 \end{pmatrix} + \mu \begin{pmatrix} 5 \\ 4 \\ b \end{pmatrix}$$

where  $\lambda$  and  $\mu$  are scalar parameters and  $b$  is a constant.

Given that  $l_1$  and  $l_2$  meet at the point  $X$ ,

(a) show that  $b = -3$  and find the coordinates of  $X$ . (5)

The point  $A$  lies on  $l_1$  and has coordinates  $(6, 3, 5)$

The point  $B$  lies on  $l_2$  and has coordinates  $(14, 9, -9)$

(b) Show that angle  $AXB = \arccos\left(-\frac{1}{10}\right)$  (4)

(c) Using the result obtained in part (b), find the exact area of triangle  $AXB$ .

Write your answer in the form  $p\sqrt{q}$  where  $p$  and  $q$  are integers to be determined. (3)

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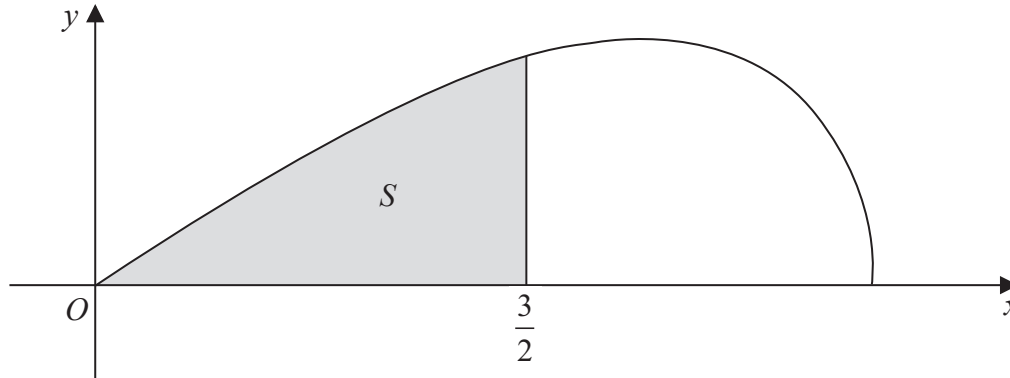


Figure 3

Figure 3 shows a sketch of the curve with parametric equations

$$x = 3 \sin t, \quad y = 2 \sin 2t, \quad 0 \leq t \leq \frac{\pi}{2}$$

The finite region  $S$ , shown shaded in Figure 3, is bounded by the curve, the  $x$ -axis and the line with equation  $x = \frac{3}{2}$

The shaded region  $S$  is rotated through  $2\pi$  radians about the  $x$ -axis to form a solid of revolution.

(a) Show that the volume of the solid of revolution is given by

$$k \int_0^a \sin^2 t \cos^3 t \, dt$$

where  $k$  and  $a$  are constants to be given in terms of  $\pi$ .

(5)

(b) Use the substitution  $u = \sin t$ , or otherwise, to find the exact value of this volume, giving your answer in the form  $\frac{p\pi}{q}$  where  $p$  and  $q$  are integers.

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

(6)

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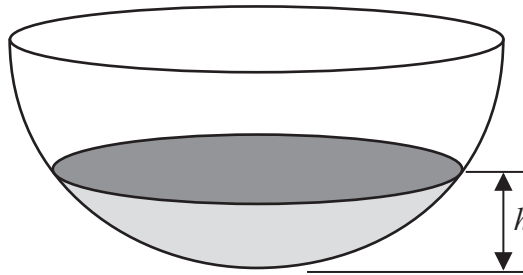


Figure 4

Figure 4 shows a hemispherical bowl containing some water.

At  $t$  seconds, the height of the water is  $h$  cm and the volume of the water is  $V$  cm<sup>3</sup>, where

$$V = \frac{1}{3}\pi h^2(30 - h), \quad 0 < h \leq 10$$

The water is leaking from a hole in the bottom of the bowl.

Given that  $\frac{dV}{dt} = -\frac{1}{10}V$

(a) show that  $\frac{dh}{dt} = -\frac{h(30 - h)}{30(20 - h)}$  (5)

(b) Write  $\frac{30(20 - h)}{h(30 - h)}$  in partial fraction form. (3)

Given that  $h = 10$  when  $t = 0$ ,

(c) use your answers to parts (a) and (b) to find the time taken for the height of the water to fall to 5 cm. Give your answer in seconds to 2 decimal places. (6)

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