Surname	Other nan	nes
Pearson Edexcel International Advanced Level	Centre Number	Candidate Number
Core Math	nematics	s C34
Tuesday 16 January 2018 – Time: 2 hours 30 minutes	•	Paper Reference WMA02/01

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 ▶



P51403A
©2018 Pearson Education Ltd.
1/1/1/1/1/1/



1. A curve *C* has equation

$$3^x + xy = x + y^2, \quad y > 1$$

The point P with coordinates (4, 11) lies on C.

Find the exact value of $\frac{dy}{dx}$ at the point *P*.

Give your answer in the form $a + b \ln 3$, where a and b are rational numbers.

1	6	٦
l	v	
•		×

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA	
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS ARE	XXXXXX
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS ARE	~~~~
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS ARE	\times
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS ARE	<
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS ARE	~~~~
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS ARE	
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS ARE	0000000 ·
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS ARE	XX = XX
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AR	
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AR	XX KM XX
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AF	
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS	XXX 0 CXX
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS	XXXXXXX
) NOT WRITE IN THIS AREA DO NOT WRITE IN THIS	
) NOT WRITE IN THIS AREA DO NOT WRITE IN THI	
) NOT WRITE IN THIS AREA DO NOT WRITE IN THI	\times
) NOT WRITE IN THIS AREA DO NOT WRITE IN THI	
) NOT WRITE IN THIS AREA DO NOT WRITE I	
) NOT WRITE IN THIS AREA DO NOT WRITE I	
) NOT WRITE IN THIS AREA DO NOT WRITE I	XXXXXX
) NOT WRITE IN THIS AREA DO NOT WRITE I	XX
) NOT WRITE IN THIS AREA DO NOT WRITE I	
) NOT WRITE IN THIS AREA DO NOT WRITE I	XX XXXX
) NOT WRITE IN THIS AREA DO NOT WRITE I	XXXXX
) NOT WRITE IN THIS AREA DO NOT WRITE I	
) NOT WRITE IN THIS AREA DO NOT WRIT	
) NOT WRITE IN THIS AREA DO NOT WRIT	~~ ~~ ~~
) NOT WRITE IN THIS AREA DO NOT WRIT	×××××
) NOT WRITE IN THIS AREA DO NOT WRIT	000000
) NOT WRITE IN THIS AREA DO NOT WRI	
) NOT WRITE IN THIS AREA DO NOT V	XX ***XX
) NOT WRITE IN THIS AREA DO NOT V	XX X XXX
) NOT WRITE IN THIS AREA DO NOT V	XXXXXXX
) NOT WRITE IN THIS AREA DO NOT V	XXXXX
) NOT WRITE IN THIS AREA DO NOT V	XX XX XX
) NOT WRITE IN THIS AREA DO NOT V	
NOT WRITE IN THIS AREA DO NOT	
) NOT WRITE IN THIS AREA DO	000
) NOT WRITE IN THIS AREA DO	00mXXXX
) NOT WRITE IN THIS AREA DO	XX ##XX
) NOT WRITE IN THIS AREA DO	XXXXXXX
) NOT WRITE IN THIS AREA DO	$\times\!\!\times\!\!\times\!\!\times\!\!\times$
) NOT WRITE IN THIS AREA DO	
) NOT WRITE IN THIS AREA DO	
) NOT WRITE IN THIS AREA	
) NOT WRITE IN THIS AREA	000 0000000000000000000000000000000000
) NOT WRITE IN THIS AREA	000000
) NOT WRITE IN THIS AREA	$\times\times\times\times\times$
) NOT WRITE IN THIS AREA	XXX XXX
) NOT WRITE IN THIS AREA	XXXXXX
) NOT WRITE IN THIS AREA	
) not write in this area	~~~~
) not write in this area	\times
) not write in this area	
) not write in this area	~~~~
) not write in this area	****
) not write in this area	***
) not write in this area	XXXXX
) not write in this area	XXXXXX
) not write in this area	
) not write in this area	~~~~
) not write in this area	
) not write in this area	
) not write in this area	XXXXX
) not write in this area	
) not write in this area	
) not write in this area	
) not write in this area	
) not write in this area	
) not write in this area	
) not write in this area	
) not write in this area	
) not write in this area	
) not write in this area	
) not write in this area	
) not write in this area	
) not write in this area	
) not write in this area	
) not write in this area	
) NOT WRITE IN THIS AREA	
NOT WRITE IN THIS ARE	
NOT WRITE IN THIS A	A
NOT WRITE IN THIS A	V :
NOT WRITE IN THIS A	
NOT WRITE IN THIS	
NOT WRITE IN THIS	
NOT WRITE IN THI	A.
NOT WRITE IN THI	A.
NOT WRITE IN THI	AREA
NOT WRITE IN THI	AREA
NOT WRITE IN	AREA
NOT WRITE II	THIS AREA
NOT WRITE II	THIS AREA
NOTWE	ITHIS AREA
NOTWE	ITHIS AREA
NOTWE	ITHIS AREA
NOTWE	ITHIS AREA
NOTWE	ITHIS AREA
NOTWE	EIN THIS AREA
NOTWR	EIN THIS AREA
W LON (TE IN THIS AREA
W LON (ITE IN THIS AREA
NOT	ITE IN THIS AREA
NOT	ITE IN THIS AREA
NOT	RITE IN THIS AREA
NOT	VRITE IN THIS AREA
Ž	T WRITE IN THIS AREA
	T WRITE IN THIS AREA
	T WRITE IN THIS AREA
	IOT WRITE IN THIS AREA
0	IOT WRITE IN THIS AREA
	NOT WRITE IN THIS AREA
×3×	NOT WRITE IN THIS AREA
***) not write in this area
) not write in this area
) not write in this area
~~~~~	) not write in this area

Question 1 continued	Leave blank
	01
	Q1
(Total 6 marks)	



2.	$f(x) = \left(125 - 5x\right)^{\frac{2}{3}} \qquad  x  < 25$
to	Find the binomial expansion of $f(x)$ , in ascending powers of $x$ , up to and including the term in $x^2$ , giving the coefficient of $x$ and the coefficient of $x^2$ as simplified fractions (4)
(b) U	Use your expansion to find an approximate value for $120^{\frac{2}{3}}$ , stating the value of x which you have used and showing your working. Give your answer to 5 decimal places.  (3

		$\supset$			
Λ		5			
				S	2
	ú	É		Ì	5
	3	7	٤	ų	ò
V	ï	Й	ĺ.	à	Ŕ
	4	×	Ę	ø	ĸ
	4	'n	ú	ú	۲
×	J			í	ď
	2	S	2	ú	ρ
	J	ς		Ľ	$\geq$
				₹	5
	ì		S	ś	S
	1	и	y,	a	ß.
	í	3		ã	K
	Š	2	ć	-	K
		3	ľ	2	
Ä	ė	5	7	7	Ų
		K	è	ś	P
	I				
	2		7	2	5
	7	Z	ä	P	5
	4	β	ě	è	K
	4	è	ij	è	Κ
		$\rangle$			
×		Ñ		9	P
×	2	7	7	7	Þ
	1	ĸ	è	á	è
	9		>		
	9	2	5	2	5
V	1			7	۲,
	8	7	7	7	К
	ē	2	ij	ù	K
	Ą			S	2
×	á	Ė	ø	5	2
	à	ĸ			
	ı	K	ù	ń	ù
	9	Ľ	4	ζ	
	1	6	2	a	Ь
V	4	þ	ú	ρ	۲,
	'n	į	é	à	Ŕ
	4	à	e	5	3
	ĕ	7	7	3	ľ
×	ż	Š	2	S	
	1	ĸ		۹	P
	3	ų	Ú	ę	5
	à	ø	۹	ij	S
	1	12	S	4	Ь
Ç	ζ	2	₹	7	<
	K	>			
		>			
		S			
		S			

Question 2 continued	Leave
	Q2
/m , 1 = 1 \	
(Total 7 marks)	



blank

3.  $f(x) = \frac{x^2}{4} + \ln(2x), \qquad x > 0$ 

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

$$x = \frac{1}{2} e^{-\frac{1}{4}x^2}$$

**(2)** 

The equation f(x) = 0 has a root near 0.5

(b) Starting with  $x_1 = 0.5$  use the iterative formula

$$x_{n+1} = \frac{1}{2} e^{-\frac{1}{4}x_n^2}$$

to calculate the values of  $x_2$ ,  $x_3$  and  $x_4$ , giving your answers to 4 decimal places.

(3)

(c) Using a suitable interval, show that 0.473 is a root of f(x) = 0 correct to 3 decimal places.

**(2)** 

Leave

Question 3 continued	blank
	Q3
(Total 7 marks)	



4.

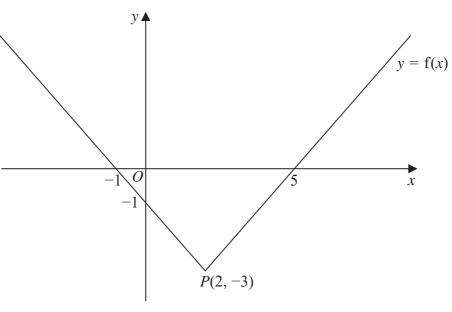


Figure 1

Figure 1 shows a sketch of part of the graph with equation y = f(x),  $x \in \mathbb{R}$ 

The graph consists of two half lines that meet at the point P(2, -3), the vertex of the graph.

The graph cuts the y-axis at the point (0, -1) and the x-axis at the points (-1, 0) and (5, 0).

Sketch, on separate diagrams, the graph of

(a) 
$$y = f(|x|)$$
, (3)

(b) 
$$y = 2f(x + 5)$$
.

In each case, give the coordinates of the points where the graph crosses or meets the coordinate axes.

Also give the coordinates of any vertices corresponding to the point P.

Question 4 continued	Leave blank



Question 4 continued	Leave blank

Leave

blank Question 4 continued Q4 (Total 6 marks)



5. (a) Express  $\frac{9(4+x)}{16-9x^2}$  in partial fractions.

(3)

Given that

$$f(x) = \frac{9(4+x)}{16-9x^2}, \quad x \in \mathbb{R}, \quad -\frac{4}{3} < x < \frac{4}{3}$$

(b) express  $\int f(x) dx$  in the form  $\ln(g(x))$ , where g(x) is a rational function.

**(4)** 



á	Ś		
	ģ		
	4		
	7		
	2		
		i	
	õ		

Question 5 continued	Leave blank
	Q5
(Total 7 marks)	



blank

**6.** 

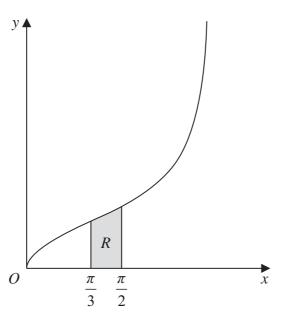


Figure 2

The curve shown in Figure 2 has equation

$$y^2 = 3\tan\left(\frac{x}{2}\right), \qquad 0 < x < \pi, \qquad y > 0$$

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

The region R is rotated through  $360^{\circ}$  about the x-axis to generate a solid of revolution.

Show that the exact value of the volume of the solid generated may be written as  $A \ln \left( \frac{3}{2} \right)$ , where *A* is a constant to be found.

**(5)** 

	Leave
	blank
Question 6 continued	0141111
Question o continueu	



	Leave
Question 6 continued	blank
Question o continued	

	Ę		
	ki ki		
1			

Question 6 continued	Leave blank
	Q6
(Total 5 marks)	
(Total S marks)	



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

$$l_1 : \mathbf{r} = (13\mathbf{i} + 15\mathbf{j} - 8\mathbf{k}) + \lambda(3\mathbf{i} + 3\mathbf{j} - 4\mathbf{k})$$

$$l_2$$
:  $\mathbf{r} = (7\mathbf{i} - 6\mathbf{j} + 14\mathbf{k}) + \mu(2\mathbf{i} - 3\mathbf{j} + 2\mathbf{k})$ 

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, B.
  - (6)

(b) Find the acute angle between the lines  $l_1$  and  $l_2$ 

**(3)** 

The point A has position vector  $-5\mathbf{i} - 3\mathbf{j} + 16\mathbf{k}$ 

(c) Show that A lies on  $l_1$ 

**(1)** 

The point C lies on the line  $l_1$  where  $\overrightarrow{AB} = \overrightarrow{BC}$ 

(d) Find the position vector of C.

(3)



nestion 7 continued	



nestion 7 continued	

Question 7 continued	Leave blank
	Q7
(Total 13 marks)	



**8.** Given that

$$y = 8\tan(2x), -\frac{\pi}{4} < x < \frac{\pi}{4}$$

show that

$$\frac{\mathrm{d}x}{\mathrm{d}y} = \frac{A}{B + y^2}$$

where A and B are integers to be found.

(4	+

Question 8 continued	Leave blank
	<b>Q8</b>
(Total 4 marks)	



9. (a) Show that

$$\frac{\cot^2 x}{1 + \cot^2 x} \equiv \cos^2 x \tag{3}$$

(b) Hence solve, for  $0 \le x < 360^{\circ}$ ,

$$\frac{\cot^2 x}{1+\cot^2 x} = 8\cos 2x + 2\cos x$$

Give each solution in degrees to one decimal place.

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

uestion 9 continued	Duestion 9 continued		b
		nestion 9 continued	
_			



Question 9 continued	Leave blank
Question 9 continued	

×				×	
		ú	ă		ß,
			2	Ç	<
			7	79	ņ
				и	ŀ
		s		싀	ŀ
	8		_	×.	2
	4	Р		ρ	۲
×		ĸ		ĸ	ú
	7	⊽	_	$\nabla$	5
	4	à	и	μ	۲
	я	6		ĸ.	
		0	٦	7	В.
	à	К	à		C
	ч	C		а	Į.
		9	0	~	r
	'n				f)
	×	ï	×	_	ć.
×	2	7		$\overline{}$	5
V	ð			4	ŀ
			×		۲
		Ľ	_	×	٥
		7	-	~	٩,
	ø	٣,			
		×	_	×	2
	×	=			ĸ,
	d			$\sim$	Z
	×	₹	-	₹	٩
	4				ĸ,
$^{\sim}$		Χ,	ö	^	
×	ì	ĸ	Ĥ	1	ì
		Ľ		ы	ľ
	.9	-	-	-	I)
		Ŀ		4	
		۰	ņ	-	۲
	B	ĸ			
	м	×		,	В,
	d		ы		r
		K		<u>z</u>	2
	e	-	8		۲,
	я	٠	6	۵.	1
		ü	a		P)
	×	9	H)	è	ſ.
×	á	ú	ø		,
V				✓	
	4	r.		2	
			я	8	Ľ
	1		_	/	
	×á	р	۰	٩	c
		K		×I	ß
	и		ы		۲,
	2	<u>~</u>	-7	$^{\sim}$	2
	7	₹			P)
	4	d	e		
	J	=	Ħ	=	9
V		ď	^	V.	
	s	ä		ы	
	1	К		2	Ľ
	٦	ь	ద	d	ĸ
		4		ĸ	Z
	7		Ħ	×	Č
		Ľ		А	ĸ
×	3		ø	=	r
×				×	
		٦			

Question 9 continued	Leave blank
	<b>Q9</b>
(Total 9 marks)	



10. It is given that

$$f(x) = e^{-2x} \qquad x \in \mathbb{R}$$

$$g(x) = \frac{x}{x - 3} \qquad x > 3$$

(a) Sketch the graph of y = f(x), showing the coordinates of any points where the graph crosses the axes.

(2)

(b) Find the range of g

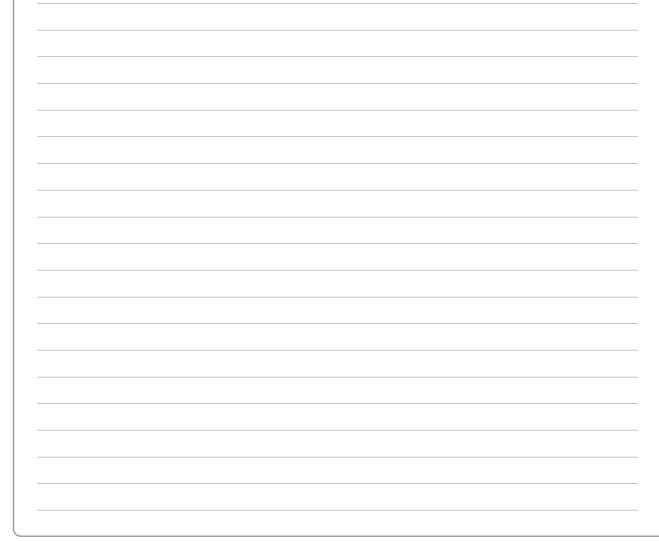
**(2)** 

(c) Find  $g^{-1}(x)$ , stating the domain of  $g^{-1}$ 

**(4)** 

(d) Using algebra, find the exact value of x for which fg(x) = 3

**(4)** 



	Leave
	blank
Question 10 continued	



estion 10 continued	
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_
	_

Leave

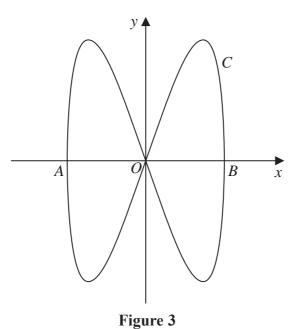
X	V.	XX	
$\times\!\!\times$	X	XX	
$\times\!\!\times\!\!$	$\times$	$\Diamond \Diamond$	
XX			
$\sim$		XX	
$\approx$			
XX	×	XX	
$\times\!\!\times$	$\times$	$\Diamond \Diamond$	
XX		$\propto \sim$	
88			
$\sim$	X	XX	
$\otimes \diamond$		$\times\!\!\times$	
XX	×	×	
××	$\sim$	80	
$\times$	歴	$\Phi \otimes$	٥
XX	'n		
$\infty$	V III O	×	
$\approx$	2	ľX	
XX	X	88	
$\times\!\!\times\!\!$	Υ'n	♦♦	
X	Y	⋬⊹	
XX		××	
$\sim$		$\times\!\!\times$	
	10	ZX	
XX	Ю		
$\times \times$	$\sim$		
XX	e	$\sim$	
$\sim$	0	₩	
$\approx$	X	ŭΧ	
XX	н	×	
$\times$	P	♦♦	
XX	20	$\stackrel{\circ}{\sim}$	
XX	P)	<b>*</b> ×	
$\infty$		₹X	
$\approx$			
XX	$\sim$	×	
$\times\!\!\times$		$\Diamond \Diamond$	
$\times$	Ŕ	$\Leftrightarrow \Diamond$	
XX		SX.	
$\bowtie$	v	×	
$\otimes$		$\times$	
	2	$\times\!\!\times$	
XX	X	88	
$\times\!\!\!\times\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!$	Ø	₩	
	'n	❖♡	
88	ĸ	YΧ	
$\otimes$		×	
$\sim$			
XX	X	88	
$\times\!\!\times\!\!$	$\times$	$\Diamond \Diamond$	
$\times\!\!\times$	$\times$	$\Diamond \Diamond$	
		$\infty$	
$\sim$	X	$\times \times$	
$\sim$		$\times\!\!\times$	
XX			
X	×	88	
XX.	$\times$	$\Diamond \Diamond$	
XX		$\times\!\!\times$	
$\sim$		XX	
$\approx$			
$\times\!\!\times\!\!$	$\times$	$\otimes$	
$\otimes$	$\otimes$	$\otimes$	
$\otimes$	$\stackrel{\times}{\otimes}$	$\overset{\circ}{\otimes}$	
$\overset{\times}{\times}$		*	
*	*		
	V 1/2		
	V		
	V		
		CHARLE A	
	Vuo		
	And A STATE OF THE COLUMN TO A CIC	1	
		1	
		1	

O NOT WRITE IN THIS AREA

Question 10 continued	blank
	Q10
(Total 12 marks)	



11.



The curve C shown in Figure 3 has parametric equations

$$x = 3\cos t$$
,  $y = 9\sin 2t$ ,  $0 \leqslant t \leqslant 2\pi$ 

The curve C meets the x-axis at the origin and at the points A and B, as shown in Figure 3.

(a) Write down the coordinates of A and B.

(2)

(b) Find the values of t at which the curve passes through the origin.

**(2)** 

(c) Find an expression for  $\frac{dy}{dx}$  in terms of t, and hence find the gradient of the curve when  $t = \frac{\pi}{6}$ 

**(4)** 

(d) Show that the cartesian equation for the curve C can be written in the form

$$y^2 = ax^2(b - x^2)$$

where a and b are integers to be determined.

**(4)** 

Question 11 continued	blank
Question 11 continued	



Question 11 continu	ıed	

			Ģ	
		S		
		ĺ		
		K		
		くしゅ イン・イフレル		
			ú	
		Š		
	£			

Question 11 continued	Leave blank
	Q11
(Total 12 marks)	



12. (a) Express  $2\sin x - 4\cos x$  in the form  $R\sin(x-\alpha)$ , where R>0 and  $0 < \alpha < \frac{\pi}{2}$ 

Give the exact value of R and give the value of  $\alpha$ , in radians, to 3 significant figures. (3)

In a town in Norway, a student records the number of hours of daylight every day for a year. He models the number of hours of daylight, H, by the continuous function given by the formula

$$H = 12 + 4\sin\left(\frac{2\pi t}{365}\right) - 8\cos\left(\frac{2\pi t}{365}\right), \qquad 0 \leqslant t \leqslant 365$$

where t is the number of days since he began recording.

(b) Using your answer to part (a), or otherwise, find the maximum and minimum number of hours of daylight given by this formula. Give your answers to 3 significant figures.

(3)

(c) Use the formula to find the values of t when H = 17, giving your answers to the nearest integer.

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

**(6)** 



Question 12 continued	blank



	Leav
	blan
Question 12 continued	Olan
Question 12 continued	

Q12	Question 12 continued	Leave blank	
(Total 12 marks)		Q12	4
	(Total 12 marks)		



blank

**(3)** 

13.

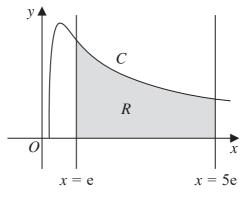


Figure 4

Figure 4 shows a sketch of part of the curve C with equation

$$y = \frac{1}{2x} \ln 2x, \qquad x > \frac{1}{2}$$

The finite region R, shown shaded in Figure 4, is bounded by the curve C, the x-axis and the lines with equations x = e and x = 5e.

The table below shows corresponding values of x and y for  $y = \frac{1}{2x} \ln 2x$ . The values for y are given to 4 significant figures.

X	e	2e	3e	4e	5e
у	0.3114	0.2195	0.1712	0.1416	0.1215

- (a) Use the trapezium rule with all the y values in the table to find an approximate value for the area of R, giving your answer to 3 significant figures.
- (b) Using the substitution  $u = \ln 2x$ , or otherwise, find  $\int \frac{1}{2x} \ln 2x \, dx$  (3)
- (c) Use your answer to part (b) to find the true area of R, giving your answer to 3 significant figures. (2)
- (d) Using calculus, find an equation for the tangent to the curve at the point where  $x = \frac{e^2}{2}$ , giving your answer in the form y = mx + c where m and c are exact multiples of powers of e.

  (5)



Question 13 continued	blank



	Leave
Omention 12 continued	blank
Question 13 continued	

					>	ς	
			×		×		
	5						
				×			
						2	
				×			
					>		
					5		
			С	S	ú	à	
		J		5		Г	
			Z	7	9	ij	
		٦	ı	ï		4	
			X EXEXXXXX		í		
		d	ä		2	'n	i
			E			C	
		×	₹	•	5	7	
		4	4	ú		ø	
		J	ς	è		L	
				7	5	7	۰
						2	
			r	Ы	Р	٩	۱
		g	ч	P		4	
		î		ė		Ħ	
		š		ä	í	è	
			75		Г		
		ì	×		h	á	
		ĭ	B.			2	
			μ	Ħ	p	¢	
		J	ĸ			Š	
		0	V	2	S	2	
		×	₹			,	
	<	4			í	è	
		i	ź	-	Ź	ď	
		4	ø	d	Š	ď	
þ		×	ú	8		2	
			ĸ			ı	
		j	Ė	ė	þ	ė	
		1		Š	۵	2	
			r	7		7	١
		å	≊		2	ŝ	
		3		7	7	5	
			г			7	
		J	•	ø	þ	ij	
		J	×		2	S	
		٦	ú	G	P	p	۰
		×	3	H	ģ	ù	
		d		ę	۰	5	
			×				
			Ŀ	۵	4	2	
		4	г	7	7	7	
		á			ij	b	
						3	
		27	9	ĕ	ø	Р	
		4	7	ú	ì	è	
			3	d	ρ	8	
		J		×	þ	ø	
	۲				ι	2	
		s	a	ø	Ŕ	è	
		4	ι	š	í	d	,
		4	Ş	į		į	
		×				į	
	3	1	Ĺ				
	2	į					
		1	(				
	3	1	X				
	3	1	X				
		1	\ \ \ \				
			XXXX				
			XXXX				
		T X X X X X X	X				
			XXXXX				
			XXXXXX				
			S X X X X X X X X X X X				
			S X X X X X X X X X X X X X X X X X X X				
			S X X X X X X X X X X X X X X X X X X X				
			S X X X X X X X X X X X X X				

K		×		$\rangle$	
×		×		S	?
j	Κ	Ų	?	ς	
	Κ		>		
٦		٢	>	C	>
×				2	ς
K		×		>	≺
K		×		$\rangle$	
ż	Ŋ	×	?	S	2
Ż		į	>	ς	2
			$\rangle$		>
	ķ		à	ń	þ
×	J	۹	Ę		L
K	ì	ř	ζ	2	ζ
X		Ļ		Ь	4
ż	5			Z	Z
Ĵ		ľ			2
	ĕ		7	₹	3
×	á	ă	ij		r
K	J	•	ę	ø	ij
X		×		$\rangle$	
K	ì	Ļ	S	И	ą
ż	×		ρ	۲,	A
	4	į	þ	ę	ņ
	4	ĺ	ij	ø	è
×	Š	2		Ľ	2
×	å	ř	7	7	7
K	1	þ	Ó	è	ó
Z	4		?	5	2
į	ï		ì	Ĺ	ì
	8	ď	à	ĕ	2
٦	į		9	۳	4
×	J		9		۹
K					ζ
K	1	Ŀ		Ŀ	₫
Ŕ	9	7	7	5	7
Ĵ	į	ŀ	à	6	ì
	Ą		5	7	
٩	J		9	ŧ	9
	1	P	٩	И	ę
K	J	ŀ	é	þ	ij
×	3	þ	ø	è	4
ż	ĭ	í			Z
è	í	i	á		ø
Ĵ			$\rangle$		>
		ľ	۵		$\leq$
×	J	ľ	ζ	7	7
K	á	þ	ę	9	ij
K	3	ļ	2	2	d
K	Š	i	2	z	2
ò	į			ä	р
	d	į	í	ú	è
٦		4	5	2	>
×	á	j	Ŗ	P	ij
K	3	k	(	2	4
×					7
ż	٦	ř	7	3	3
Ĵ	1	b	ì	É	d
			>		$\rangle$
1	J		١.	1	\

Question 13 continued	Leave blank
	Q13
(Total 13 marks)	



Leave blank

- **14.** The volume of a spherical balloon of radius r cm is V cm³, where  $V = \frac{4}{3}\pi r^3$ 
  - (a) Find  $\frac{dV}{dr}$

The volume of the balloon increases with time t seconds according to the formula

$$\frac{\mathrm{d}V}{\mathrm{d}t} = \frac{9000\pi}{(t+81)^{\frac{5}{4}}} \qquad t \geqslant 0$$

(b) Using the chain rule, or otherwise, show that

$$\frac{\mathrm{d}r}{\mathrm{d}t} = \frac{k}{r^n(t+81)^{\frac{5}{4}}} \qquad t \geqslant 0$$

where k and n are constants to be found.

(2)

Initially, the radius of the balloon is 3 cm.

(c) Using the values of k and n found in part (b), solve the differential equation

$$\frac{\mathrm{d}r}{\mathrm{d}t} = \frac{k}{r^n(t+81)^{\frac{5}{4}}} \qquad t \geqslant 0$$

to obtain a formula for r in terms of t.

**(6)** 

(d) Hence find the radius of the balloon when t = 175, giving your answer to 3 significant figures.

**(1)** 

(e) Find the rate of increase of the radius of the balloon when t = 175. Give your answer to 3 significant figures.

**(2)** 

	1
uestion 14 continued	



	Leav
	blan
On office 14 confirmed	Olan
Question 14 continued	

	Leave
	blank
Question 14 continued	0141111
Question 14 continued	



	Leave blank
Question 14 continued	
	Q14
(Total 12 marks)	
TOTAL FOR PAPER: 125 MARKS	
END	