



GCE A LEVEL

1300U30-1

TUESDAY, 4 JUNE 2024 – MORNING

MATHEMATICS – A2 unit 3

PURE MATHEMATICS B

**2 hours 30 minutes plus your additional
time allowance**

Surname _____

First name(s) _____

Centre Number _____

Candidate Number 2 _____

For Examiner's use only

Question	Maximum Mark	Mark Awarded
1	11	
2	11	
3	7	
4	6	
5	4	
6	13	
7	7	
8	7	
9	9	
10	14	
11	10	
12	6	
13	3	
14	7	
15	5	
Total	120	

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

- **a Formula Booklet;**
- **a calculator.**

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball-point pen or your usual method.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces provided on the front cover.

Answer ALL questions.

(Turn over)

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The maximum mark for this paper is 120.

The number of marks is given in brackets at the end of each question or part-question.

Sufficient working must be shown to demonstrate the MATHEMATICAL method employed.

Answers without working may not gain full credit.

(Turn over)

4

Unless the degree of accuracy is stated in the question, answers should be rounded appropriately.

You are reminded of the necessity for good English and orderly presentation in your answers.

(Turn over)

REMINDER: Sufficient working must be shown to demonstrate the MATHEMATICAL method employed.

1. The function f is given by

$$f(x) = \frac{25x + 32}{(2x - 5)(x + 1)(x + 2)}$$

(a) Express $f(x)$ in terms of partial fractions. [4 marks]

(Turn over)

(Turn over)

1 (b) Show that $\int_1^2 f(x) dx = -\ln P$

where P is an integer whose value is to be found. [5 marks]

(Turn over)

9

(Turn over)

1 (c) Show that the sign of $f(x)$ changes in the interval $x = 2$ to $x = 3$

Explain why the change of sign method fails to locate a root of the equation $f(x) = 0$ in this case.

[2 marks]

2 (a) Find all values of θ in the range $0^\circ < \theta < 360^\circ$ satisfying

$$3\cot\theta + 4\operatorname{cosec}^2\theta = 5$$

[5 marks]

(Turn over)

15

(Turn over)

2 (b) By writing $24\cos x - 7\sin x$ in the form $R\cos(x + \alpha)$

where R and α are constants with $R > 0$ and $0^\circ < \alpha < 90^\circ$

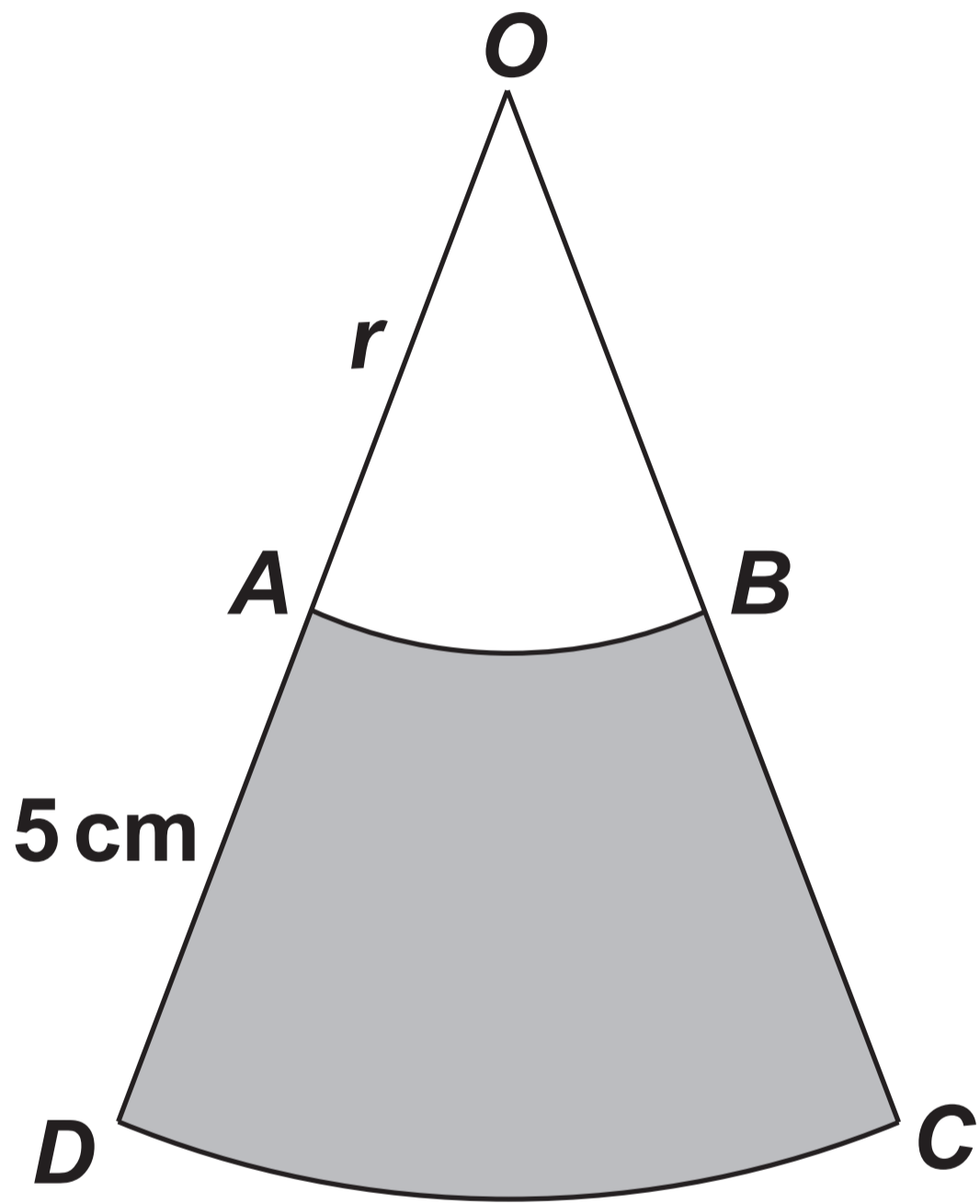
solve the equation

$$24\cos x - 7\sin x = 16$$

for values of x between 0° and 360°
[6 marks]

(Turn over)

(Turn over)



3. The diagram opposite shows a badge ODC

The shape OAB is a sector of a circle centre O and radius r cm

The shape ODC is a sector of a circle with the same centre O

The length AD is 5 cm and angle AOB is $\frac{\pi}{5}$ radians

The area of the shaded region $ABCD$ is $\frac{13\pi}{2}$ cm²

- (a) Determine the value of r [4 marks]

(Turn over)

3 (b) Calculate the perimeter of the shaded region. [3 marks]

(Turn over)

(Turn over)

4. A function f is given by
 $f(x) = |3x + 4|$

(a) Sketch the graph of $y = f(x)$

Clearly label the coordinates of the point A where the graph meets the X -axis, and the coordinates of the point B where the graph cuts the y -axis.

[3 marks]

(Turn over)

4 (b) On a separate set of axes, sketch the graph of $y = \frac{1}{2} f(x) - 6$

where the points A and B are

transformed to the points A' and B'

Clearly label the coordinates of the points A' and B' [3 marks]

5. Prove by contradiction the following proposition:

When X is real and positive,

$$x + \frac{81}{x} \geq 18$$

[4 marks]

(Turn over)

(Turn over)

(Turn over)



6 (b) Differentiate $e^{3x}\sin 4x$ with respect to x [3 marks]



(Turn over)

40

(Turn over)

7. Showing all your working, evaluate

(a) $\sum_{r=3}^{50} (4r + 5)$ [4 marks]

(Turn over)

7 (b) $\sum_{r=2}^{\infty} \left(540 \times \left(\frac{1}{3} \right)^r \right)$

[3 marks]

(Turn over)

(Turn over)

8. The function f is defined by

$$f(x) = x^3 + 4x^2 - 3x - 1$$

(a) Show that the equation $f(x) = 0$
has a root in the interval $[0, 1]$

[1 mark]

(Turn over)

8 (b) Using the Newton-Raphson method with $x_0 = 0.8$

(i) write down in full the decimal value of x_1 as given in your calculator,

(ii) determine the value of this root correct to six decimal places.

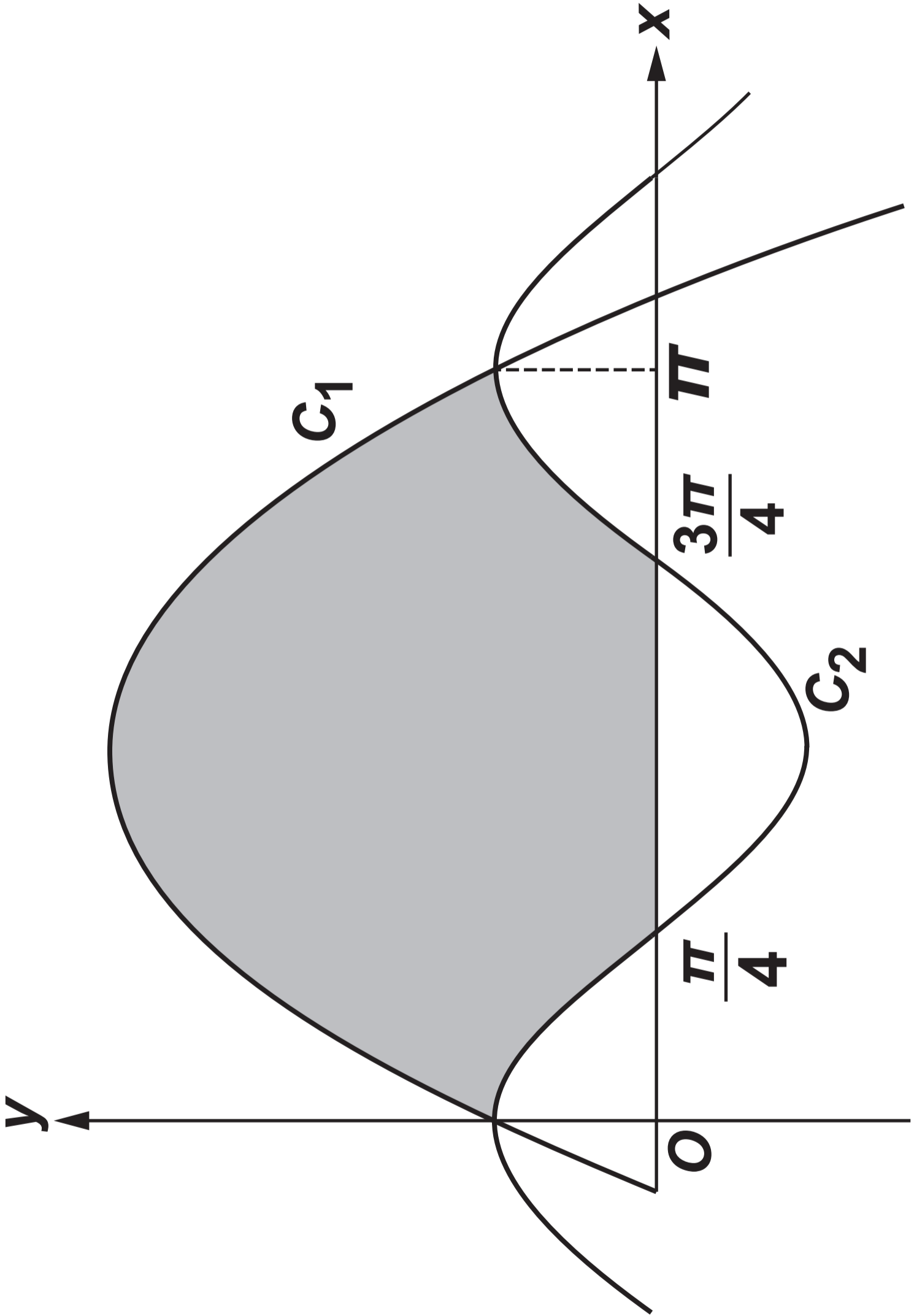
[4 marks]

(Turn over)

8 (c) Explain why the Newton-Raphson method does not work if $x_0 = \frac{1}{3}$

[2 marks]

(Turn over)



9. The diagram opposite shows a sketch of the curve C_1 with equation $y = -x^2 + \pi x + 1$ and a sketch of the curve C_2 with equation $y = \cos 2x$

The curves intersect at the points where $x = 0$ and $x = \pi$

Calculate the area of the shaded region enclosed by C_1 , C_2 and the x -axis. Give your answer in terms of π [9 marks]

(Turn over)

(Turn over)

(Turn over)

(Turn over)

10. The function f has domain $[4, \infty)$ and is defined by

$$f(x) = \frac{2(3x + 1)}{x^2 - 2x - 3} + \frac{x}{x + 1}$$

- (a) Show that $f(x) = \frac{x + 2}{x - 3}$ [4 marks]

(Turn over)

10 (b)

Determine the range of $f(x)$

[2 marks]

(Turn over)

10 (c)

Find an expression for $f^{-1}(x)$ and write down the domain and range of f^{-1} [4 marks]

(Turn over)

60

(Turn over)

10 (d)

Find the value of X when

$$f(x) = f^{-1}(x)$$

[4 marks]

11. A curve is defined parametrically by

$$x = 2\theta + \sin 2\theta$$

$$y = 1 + \cos 2\theta$$

(a) Show that the gradient of the curve at the point with parameter θ is $-\tan\theta$ [6 marks]

(Turn over)

11 (b)

Find the equation of the tangent to the curve at the point where $\theta = \frac{\pi}{4}$

[4 marks]

(Turn over)

(Turn over)

12 (a)

Given that θ is small, show that

$$\mathbf{2\cos\theta + \sin\theta - 1 \approx 1 + \theta - \theta^2}$$

[2 marks]

12 (b)

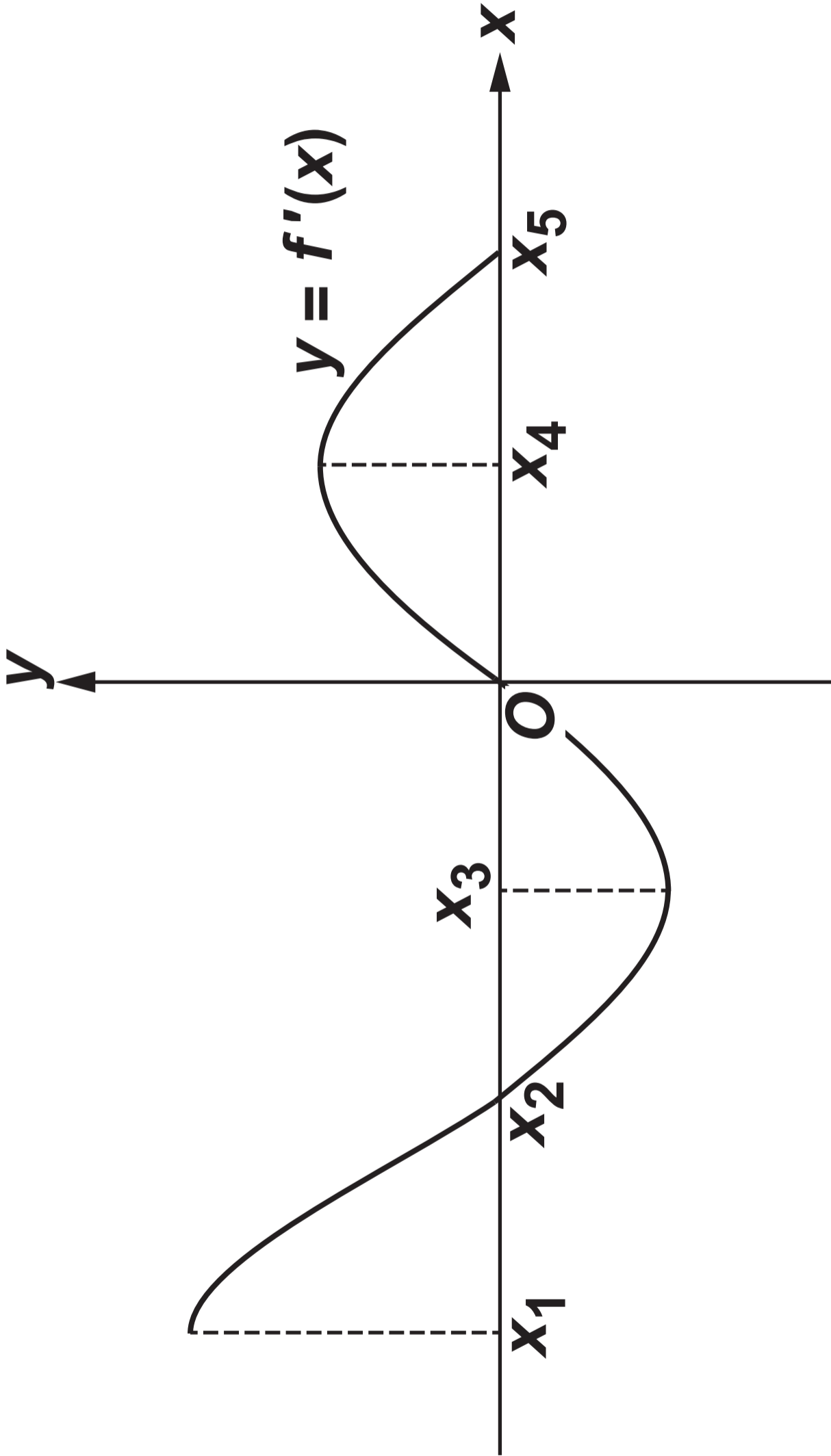
Hence, when θ is small, show that

$$\frac{1}{2\cos\theta + \sin\theta - 1} \approx 1 + a\theta + b\theta^2$$

where a , b are constants to be found.

[4 marks]

(Turn over)



13. The diagram opposite shows a sketch of the graph of $y = f'(x)$ for the interval $[x_1, x_5]$
- (a) Find the interval on which $f(x)$ is both decreasing and convex. Give reasons for your answer. [2 marks]

(Turn over)

13 (b)

Write down the ***X***-coordinate of a point of inflection of the graph of **$y = f(x)$**

[1 mark]

(Turn over)

14 (a)

Given that $y = \frac{1 + \ln x}{x}$ show that

$$\frac{dy}{dx} = \frac{-\ln x}{x^2}$$

[2 marks]

(Turn over)

14 (b)

Hence, solve the differential equation

$$\frac{dx}{dt} = \frac{x^2 t}{\ln x}$$

given that $t = 3$ when $x = 1$

Give your answer in the form

$t^2 = g(x)$ where g is a function
of x

[5 marks]

(Turn over)

81

(Turn over)

82

(Turn over)

15. Robert wants to deposit $\text{£}P$ into a savings account. He has a choice of two accounts.

- Account A offers an annual compound interest rate of 1%
- Account B offers an interest rate of 5% for the first year and an annual compound interest rate of 0.6% for each subsequent year.

After n years, account A is more profitable than account B

Find the smallest value of n

[5 marks]

(Turn over)

END OF PAPER

(Turn over)

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