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OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Monday 15 May 2023 – Afternoon

Level 3 Cambridge Technical in Engineering

05822/05823/05824/05825/05873

Unit 1: Mathematics for engineering

Time allowed: 1 hour 30 minutes plus your additional time allowance

You must have:

**the Formula Booklet for Level 3
Cambridge Technical in Engineering
(with this document)**

a ruler (cm/mm)

a scientific calculator

Please write clearly in black ink.

**Centre
number**

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**Candidate
number**

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First name(s) _____

Last name _____

**Date of
birth**

D	D	M	M	Y	Y	Y	Y
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READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS

Use black ink. You can use an HB pencil, but only for graphs and diagrams.

Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.

Answer ALL the questions.

Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

Give your final answers to a degree of accuracy that is appropriate to the context.

INFORMATION

The total mark for this paper is 60.

The marks for each question are shown in brackets [].

ADVICE

Read each question carefully before you start your answer.

1 (a) Solve the equation $3(x - 4) + 2 = 11$.

[3]

(b) Write as a single fraction in its simplest terms.

$$\frac{x-1}{3} + \frac{x}{4}$$

[3]

(b) You are given the cubic function

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

(i) Show that $f(x)$ can be written as

$$f(x) = (x + 1)(x^2 - 5x + 6).$$

[2]

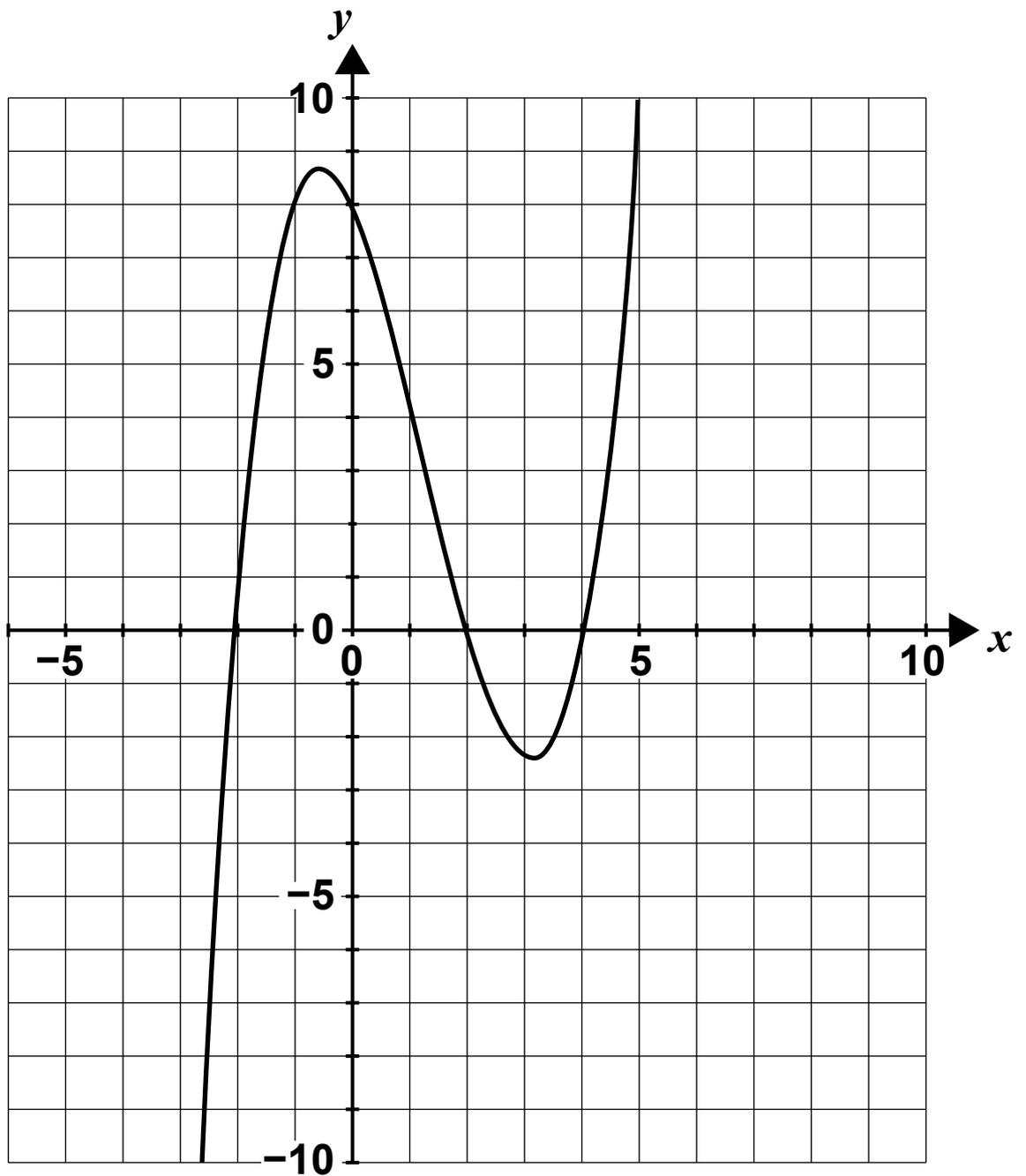
(ii) Hence solve the equation $f(x) = 0$.

[3]

- 3 (a) The formula $A = \left(\frac{8d}{9}\right)^2$ was used to calculate the approximate area of a circle with diameter d .
Rearrange the formula to make d the subject.

[3]

(b) The graph of $y = f(x)$ is shown on the grid.



On the grid sketch the graph of the curve $y = f(x) - 4$. [2]

- (c) A population of bacteria grows according to the formula

$$N = 1000 \times 1.5^t$$

where N is the number of bacteria present at time t hours after the start of observations.

- (i) What is the significance of the number 1000?

[1]

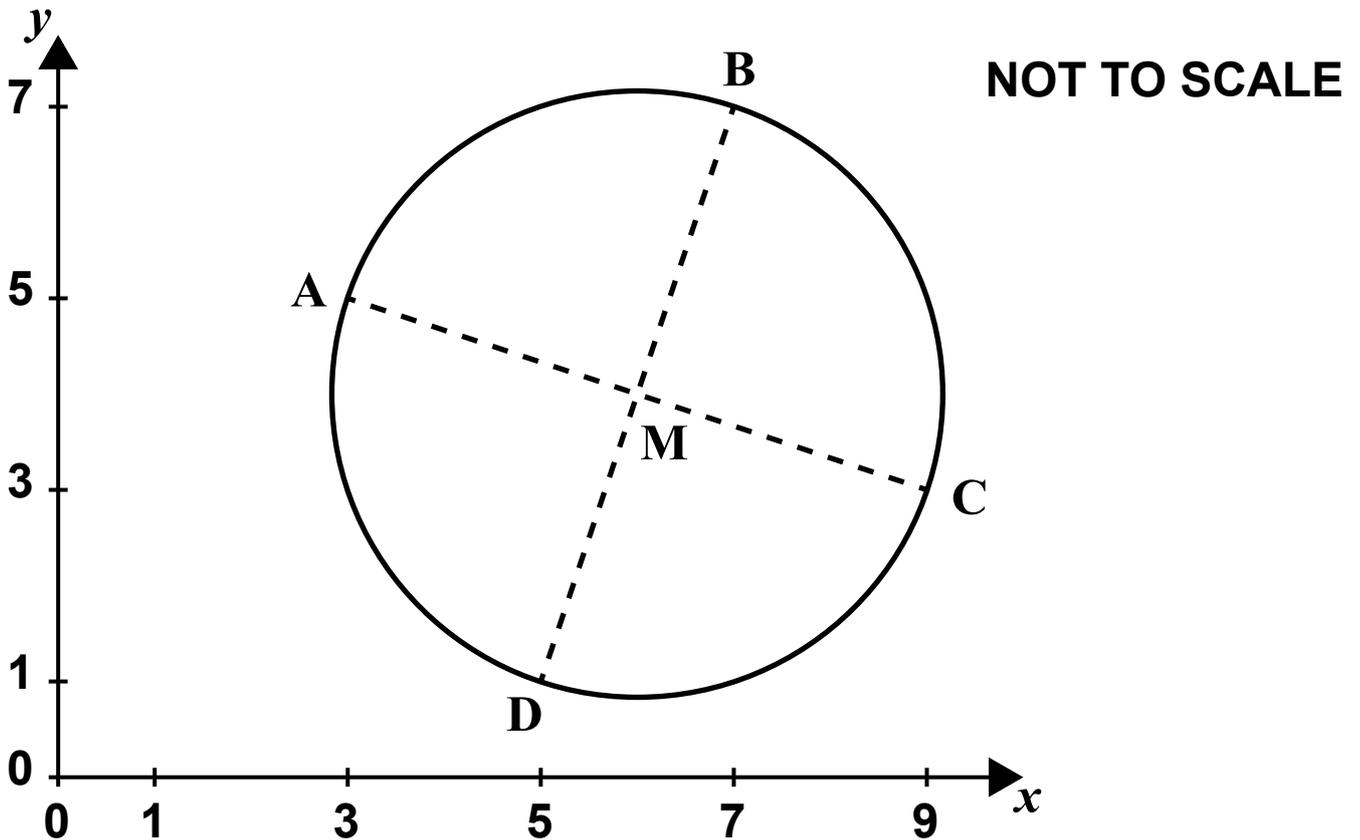
- (ii) Using logarithms, determine after how many complete hours the population first exceeds 1 million.

[4]

4 A circle is to be marked on flat ground.

Four points, A, B, C and D are to be marked equally spaced around the circle.

A coordinate system is set up on the ground. Units are metres.



The coordinates of A are (3, 5) and the coordinates of C are (9, 3).

(a) Determine the coordinates of M, the midpoint of AC.

You must show your calculations.

(b) Find the distance AC.

[2]

(c) Find the equation of the circle given that AC is a diameter and M is the centre.

[2]

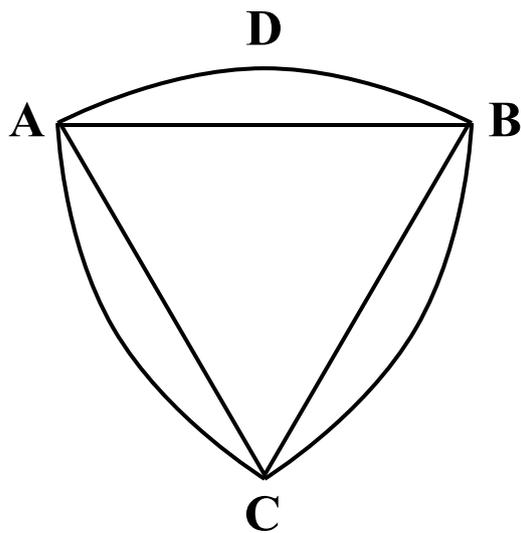
(d) B and D lie on a diameter of the circle. The line BD is perpendicular to the line AC.

Find the equation of the line BD.

[4]

5 A company manufactures plastic tokens.

The shape of the token is shown in the diagram. It is an equilateral triangle ABC together with three circular arcs. The sides of the triangle ABC have length 20 mm. The arc ADB on the side AB has centre C and the other two arcs are defined similarly.



NOT TO SCALE

(a) Calculate

(i) the area of the triangle ABC .

[2]

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(ii) the area of the sector $CADB$.

[2]

(b) Hence calculate the area of the token.

[3]

- 6 The length of 50 bolts, selected at random from a production line, were measured to the nearest 0.1 mm.

The data are displayed in this table.

Length (l mm)	Frequency
$58.5 \leq l < 59.5$	5
$59.5 \leq l < 60.5$	10
$60.5 \leq l < 61.5$	30
$61.5 \leq l < 62.5$	5

- (a) Calculate an estimate of the mean length of these bolts.

[4]

(b) You are given that the variance of the length of the bolts is 0.64.

(i) Write down the value of the standard deviation.

[1]

(ii) In a quality test, it is required that all bolts in the sample are within three standard deviations of 60 mm.

Determine whether all the bolts pass this test.

You must justify your answer.

[3]

- 7 An engineer is making a small box with a square base and no lid.

The volume of the box is $V \text{ cm}^3$.

Each side of the base measures $x \text{ cm}$ and the height $h \text{ cm}$.

- (a) Write down an equation for the volume of the box in terms of x and h .

[1]

The volume of the box is to be 4000 cm^3 .

- (b) Show that the formula for the surface area, S , is given by

$$S = x^2 + \frac{16000}{x}.$$

[3]



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