OCR
Oxford Cambridge and RSA

Monday 13 May 2024 – Afternoon

Level 3 Cambridge Technical in Engineering

05822/05823/05824/05825/05873 Unit 1: Mathematics for engineering

Time allowed: 1 hour 30 minutes
C301/2406

C301 – 2406

You must have:
- the Formula Booklet for Level 3 Cambridge Technical in Engineering (inside this document)
- a ruler (cm/mm)
- a scientific calculator

0 5 8 2 2 – 0 1

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

Date of birth | D | D | M | M | Y | Y | Y | Y |

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 **[ ]**.
- This document has **16** pages.

ADVICE
- Read each question carefully before you start your answer.

1

(a) Solve the equation $2x - 3 = 5$.

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..... **[2]**

(b) Factorise $2x^2 + 4x$.

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..... **[2]**

(c) Write $\frac{x+1}{3} + \frac{x-1}{2}$ as a single fraction.

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..... **[3]**

(d) You are given that $(x - 3)^2 = x^2 + ax + b$ where a and b are integers, for all values of x.

Find the values of a and b.

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..... **[3]**

(e) Solve the equation $x^2 + 4x - 7 = 0$.

Give your answers correct to **3** significant figures.

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..... **[3]**

Turn over for the next question

2

(a) You are given that $f(x) = x^3 - 13x + 12$.

You are also given that $f(1) = 0$.

Write $f(x)$ in fully factorised form.

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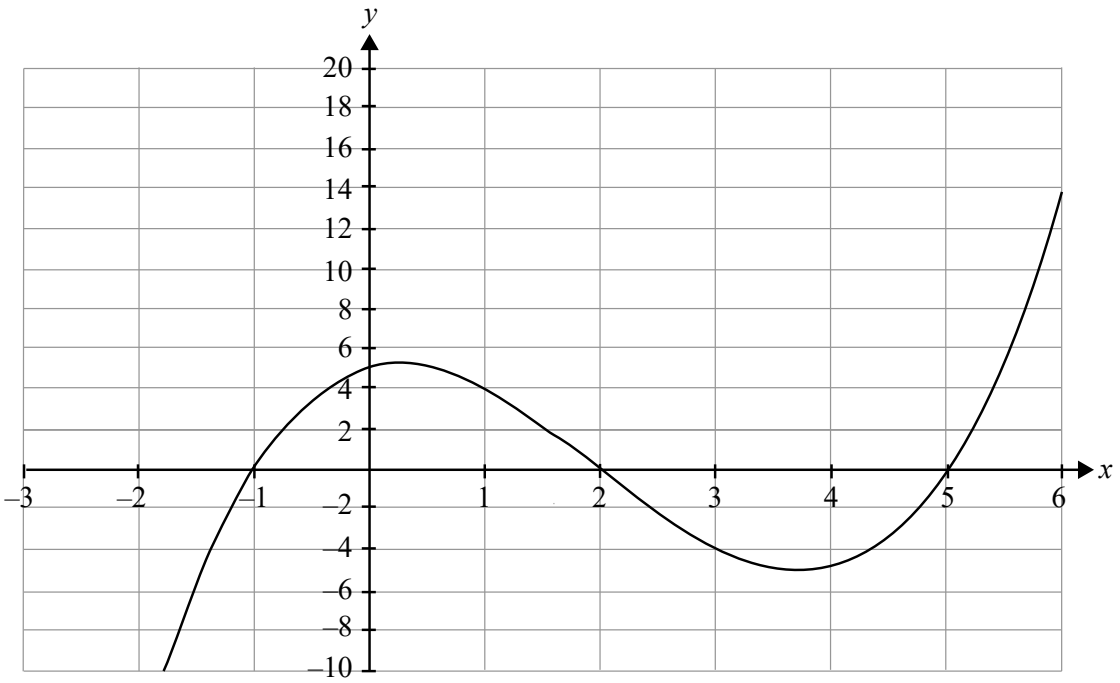
..... **[4]**

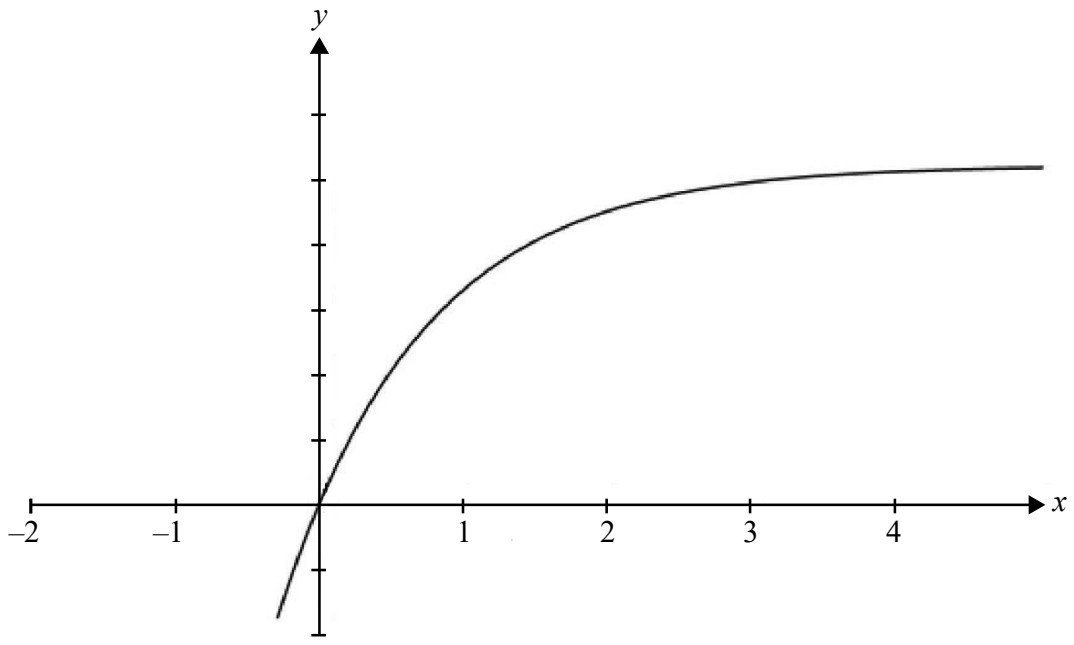
(b) The grid shows part of the graph of $y = g(x)$.



On the same grid sketch the graph $y = 2g(x)$.

[2]

(c) The grid shows part of the graph of $y = h(x)$.



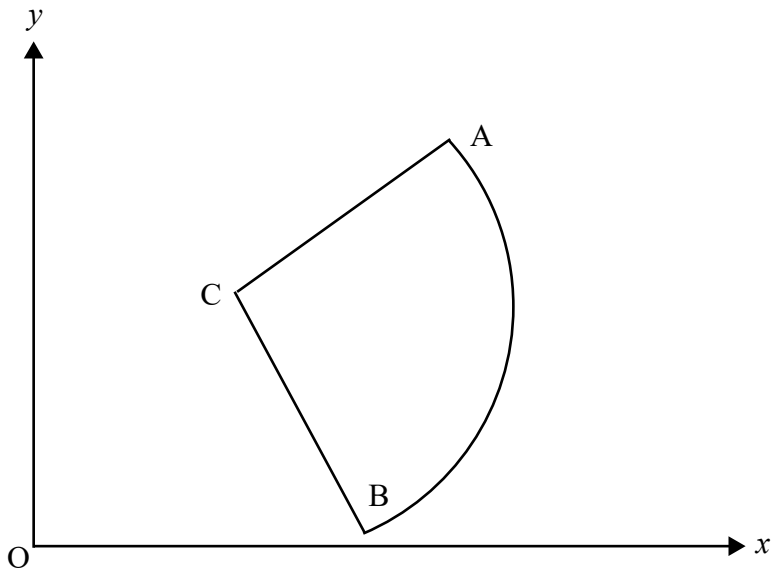
On the same grid sketch the graph of $y = h(x – 1)$.

[2]

3

(a) A part of a machine is the sector of a circle.

Drawn on a coordinate system, the equation of the circle is $x^2 + y^2 - 12x - 14y + 60 = 0$.



(i) Find the coordinates of the centre, C, and the radius of the circle.

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..... **[3]**

The sector of the circle is bounded by the lines CA, CB and the arc AB.
The coordinates of A and B are (10,10) and (9,3) respectively.

(ii) Verify that A and B lie on the circle.

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..... **[1]**

(iii) Find the distance from A to B along the straight line AB.

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..... **[2]**

(iv) Determine the angle ACB.

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..... **[3]**

(v) Find the distance from A to B along the arc of the circle.

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..... **[2]**

(b) A prop shaft is rotating at 2 radians per second.

Express this in revolutions per minute.

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..... **[2]**

4

(a) Four students are asked to select a sample of 20 students from their year group to undertake a survey.

The year group consists of 100 students, split into 5 equal classes of 20.

- Alex selects as his sample the whole of one class to represent the year group.
- Beth selects as her sample the first 20 students in the year group who enter the school one morning.
- Charlie chooses the first 20 students from the alphabetical list of students.
- Dev assigns a number to each student, writes the numbers onto pieces of paper and puts them all into a hat. He then pulls out 20 pieces of paper and the 20 numbers are the students in his sample.

Which **one** of the students has chosen a random sample?

Tick (✓) **one** box only.

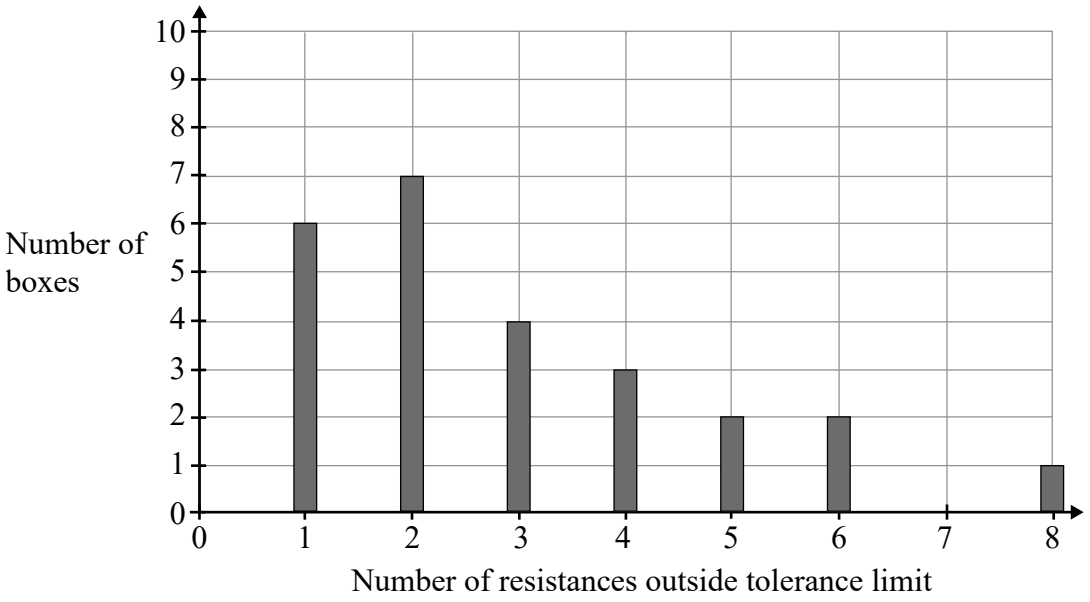
Alex	
Beth	
Charlie	
Dev	

[1]

(b) Resistors made by a company are distributed in boxes of 50 resistors.

A number of boxes were checked and the vertical line chart below summarises the number of resistors in each box that had a resistance outside the tolerance limit.

Every box checked had at least 1 resistor that was outside the tolerance limits.



(i) How many boxes were checked?

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..... **[2]**

(ii) Find the median number of resistors per box that were outside the tolerance limit.

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..... **[2]**

(iii) One box is chosen at random from this set of boxes.

Find the probability that the number of resistors outside the tolerance limit exceeds 3.

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..... **[2]**

5 When a capacitor, C, is discharged through a resistor, R, the voltage, V, at time t, is given by the formula $V = 12e^{\frac{-t}{RC}}$ where $RC = 1.2$.

(a) Write down the initial voltage.

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..... **[1]**

The resistance of the resistor is $600\,\Omega$.

(b) Find the value of the capacitor, stating your units.

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(c) Find the voltage after 3 seconds.

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(d) Calculate after how many seconds the voltage is 1.2 V.

Give your answer to **3** significant figures.

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Turn over for the next question

6 The curve $y = \frac{x^3}{8} - \frac{3x^2}{4} + 5$ has two stationary points.

(a) Use calculus to show that the coordinates of the turning points are (0, 5) and (4, 1).

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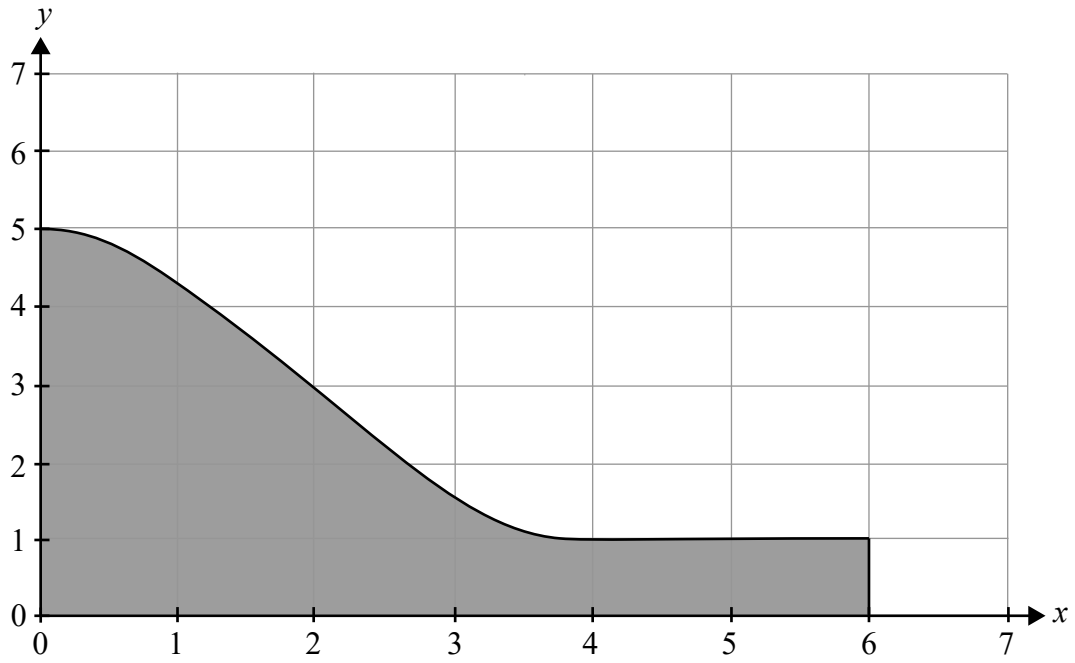
(b) The graph shows the curve $y = \frac{x^3}{8} - \frac{3x^2}{4} + 5$ for $0 \leqslant x \leqslant 4$ and the line $y = 1$ for $4 \leqslant x \leqslant 6$.

It represents the side of a playground slide.

Units are metres.



Find the area enclosed by the axes, the line $x = 6$ and the curve.

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..... **[6]**

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.