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OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Monday 11 January 2021 – 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 | | | | | |

Candidate number | | | | |

First name(s) _____

Last name _____

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

READ INSTRUCTIONS BELOW

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.

Answer ALL the questions.

1 (a) Factorise $4x + 2y$.

_____ **[1]**

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

_____

_____

_____

_____ **[3]**

(c) Find the remainder when $x^3 + 2x^2 + 3x + 4$ is divided by $(x + 1)$.

_____

_____

_____

_____ **[2]**

(d) It is given that f(x) = x^2 + 4x – 6.

(i) Write f(x) in the form (x + a)^2 + b where a and b are integers to be determined.

_____

_____

_____

_____ [3]

(ii) Hence or otherwise find the values of x that satisfy the equation f(x) = 0, giving your answers exactly.

_____

_____

_____

_____ [2]

2 (a) It is given that f(x) = $x^3 + 2x - 3$.

(i) Show that f(1) = 0.

[1]

(ii) Factorise f(x).

[2]

(iii) Show that the equation f(x) = 0 has only one root.

[2]

(b) Rearrange $v^2 = u^2 + 2as$ to make a the subject.

_____

_____

_____

_____ [3]

3 (a) Fig. 1 on the opposite page shows part of the curve $y = \cos x$.

On Fig. 1 opposite, sketch the graph of the curve $y = \cos 2x$. [2]

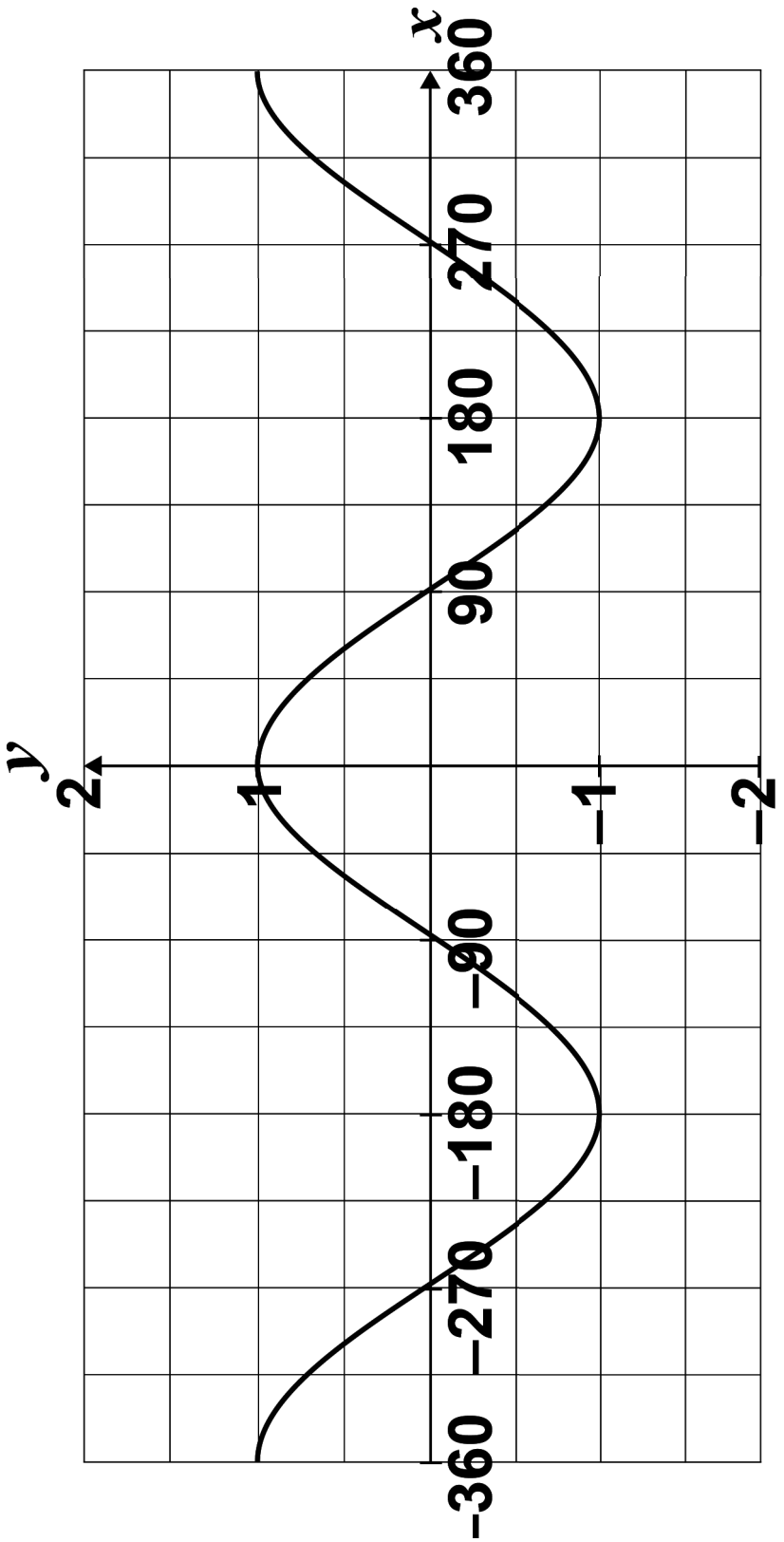


Fig. 1

(b) Fig. 2 on the opposite page shows part of the curve $y = \sin x$.

On Fig. 2 opposite, sketch the curve $y = \sin x + 1$. [2]

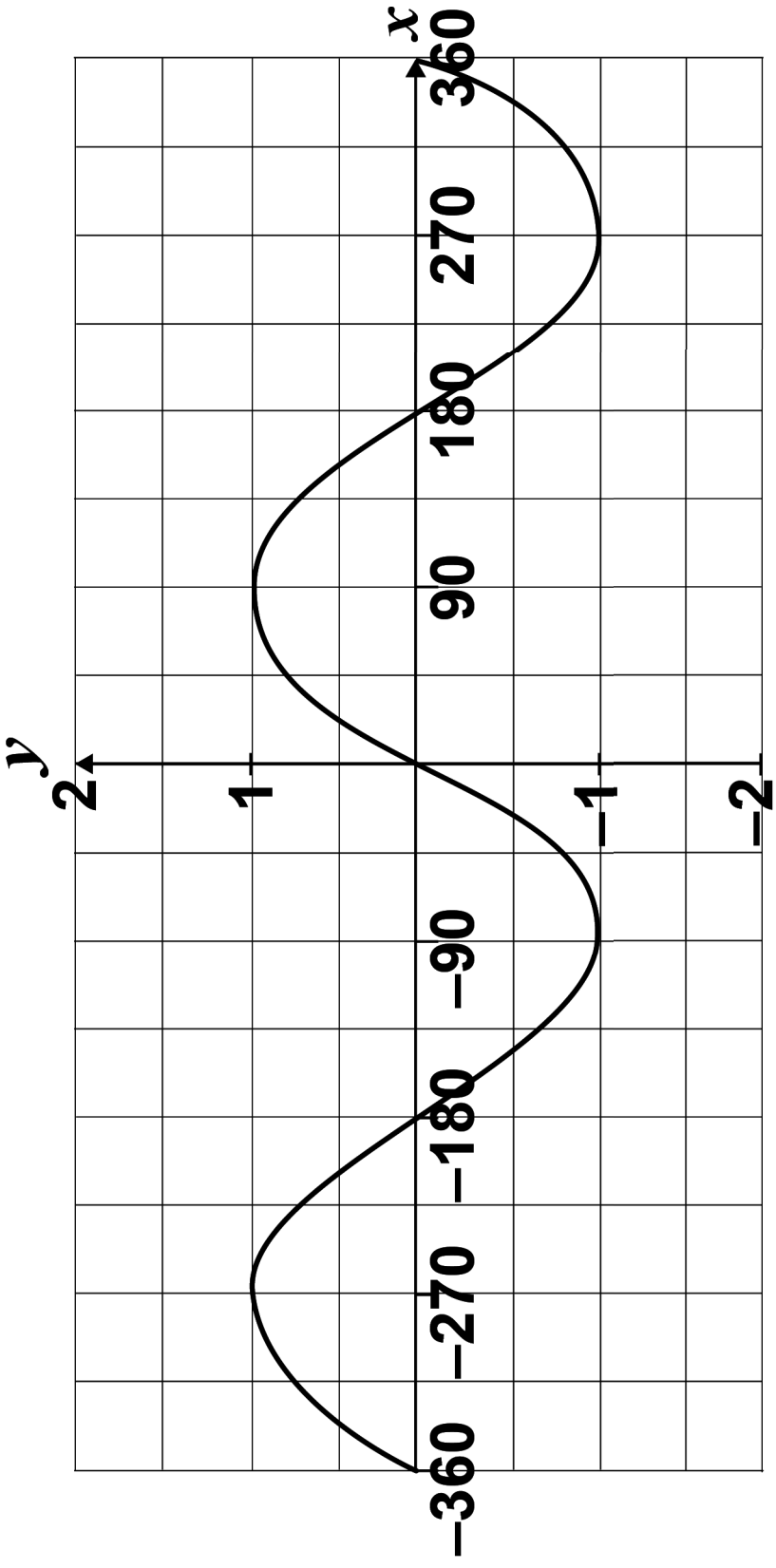
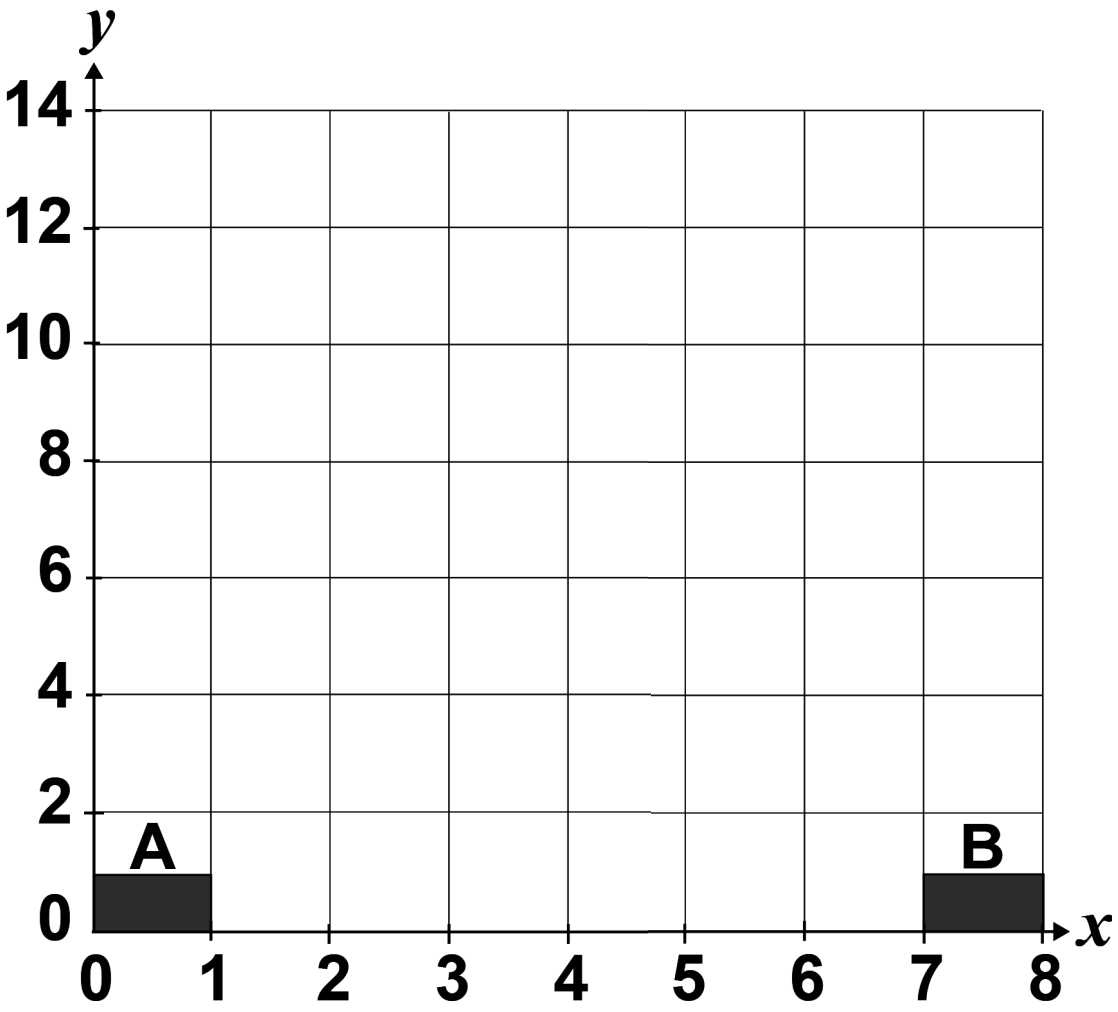


Fig. 2

(c) A supporting arch for a bridge is given on a coordinate grid where units are in metres. The bridge is symmetric about the line $x = 4$.

The base of the bridge is on supports A and B with coordinates (1, 1) and (7, 1) respectively.

Fig. 3



The arch of the bridge has equation $y = -6 + 8x - x^2$.

(i) On Fig. 3, sketch the curve $y = -6 + 8x - x^2$. [3]

(ii) Give the coordinates of the highest point of the arch.

_____

_____ [1]

4 (a) Write $\log a - 2 \log b$ as a single logarithm.

_____

_____

_____ [2]

(b) The voltage decay in a capacitor can be modelled by the formula $V = 12e^{\frac{-t}{4}}$ where V is the voltage remaining in the capacitor after t seconds.

(i) Calculate the voltage remaining after 5 seconds.

[2]

(ii) Calculate the time it takes for the initial voltage to be halved.

[3]

5 (a) Write down the exact value of tan 60°.

_____

_____ [1]

(b) An alternating current can be represented by the formula $V = 220\cos t$ where t is measured in degrees.

(i) Find the value of V when $t = 320$.

_____

_____ [1]

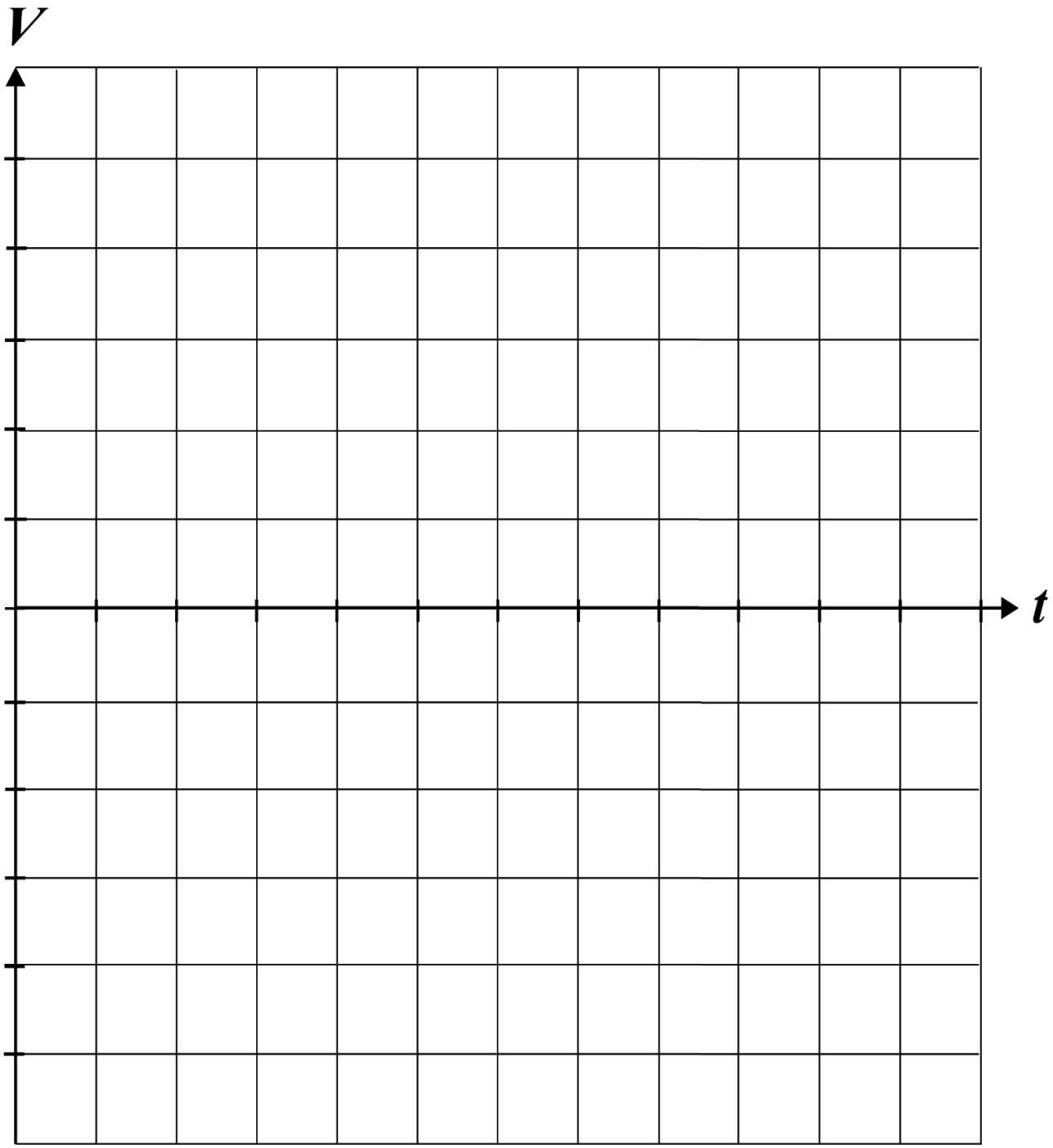
(ii) Find a value for t when $V = 180$.

_____

_____

_____ [2]

(iii) On the grid below, sketch the graph of $V = 220\cos t$ for $0° \leqslant t \leqslant 360°$. [2]



(c) A triangular metal plate, ABC, is such that AB = 6 cm, BC = 2 cm and AC = 5 cm.

Find the angle CAB.

[3]

6 A curve has equation $y = 2x^3 - 3x^2 - 12x + 4$.

(i) By differentiation, find the coordinates of the turning points of the curve.

[5]

(ii) By differentiating again, determine the nature of the turning point for which $x > 0$.

[3]

7 (a) A factory uses 3 identical machines in a manufacturing process. It has been found that the probability of a machine failing during the course of a day is 0.2, independent of other machines.

(i) What is the probability that all the machines are working at the end of the day?

[2]

(ii) Find the probability that exactly one machine fails.

[3]

(b) The thickness of steel bars coming off a production line is measured with a micrometer. The values for 25 bars, given to 2 decimal places, are given in the table below.

Thickness (mm)	9.58	9.59	9.60	9.61	9.62
Frequency	2	4	13	4	2

(i) Explain how you can tell that the mean value is 9.60 mm without doing any calculations.

_____

_____ **[1]**

(ii) Calculate the standard deviation of the data.

_____

_____

_____

_____ **[3]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined pages. The question numbers must be clearly shown – for example, 1(c) or 5(a).

Oxford Cambridge and RSA

Version 4