

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

C301/2101



You must have:

- the Formula Booklet for Level 3 Cambridge Technical in Engineering (inside 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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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 **12** pages.

ADVICE

- Read each question carefully before you start your answer.

FOR EXAMINER USE ONLY	
Question No	Mark
1	/11
2	/8
3	/8
4	/7
5	/9
6	/8
7	/9
Total	/60

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 shows part of the curve $y = \cos x$.

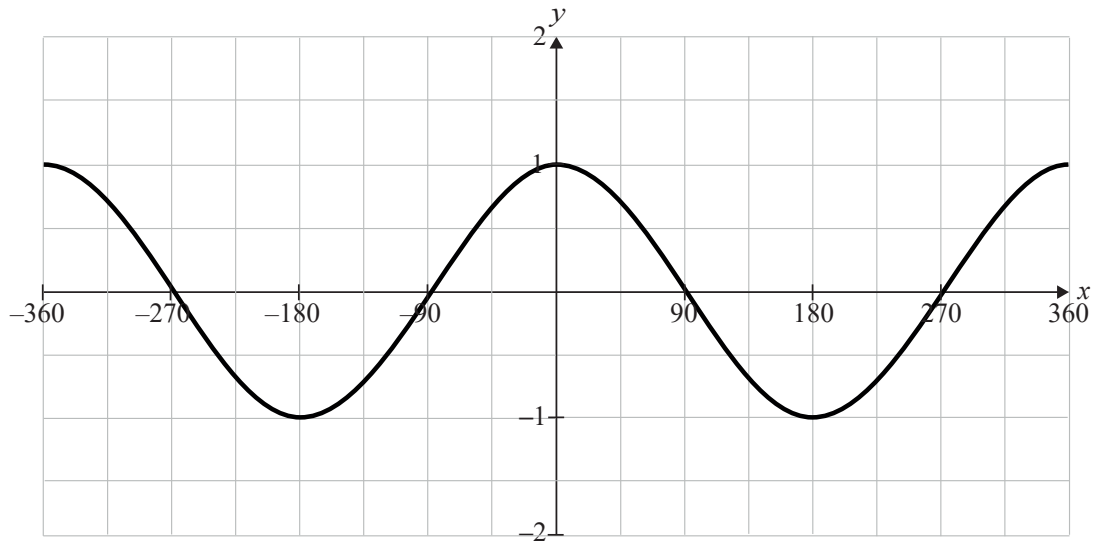


Fig. 1

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

[2]

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

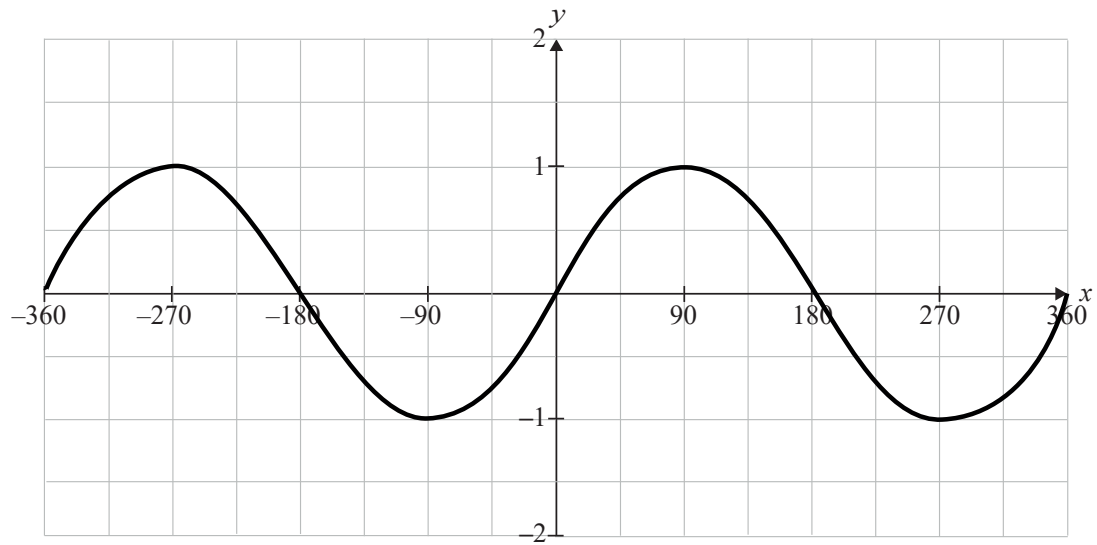


Fig. 2

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

[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.

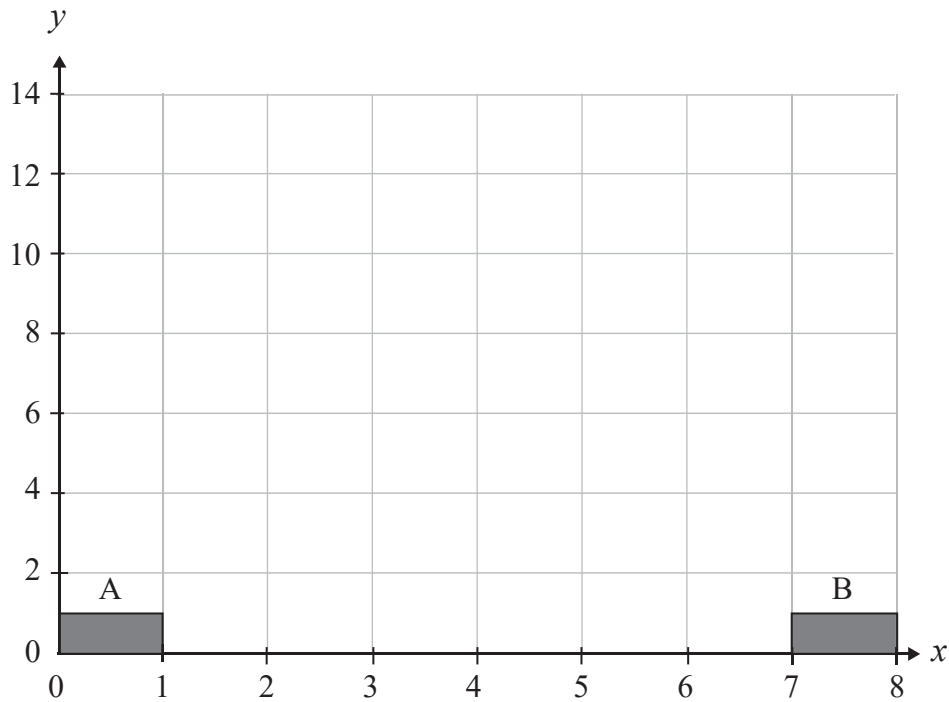


Fig. 3

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 $\tan 60^\circ$.

.....
 [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 $t = 320$.

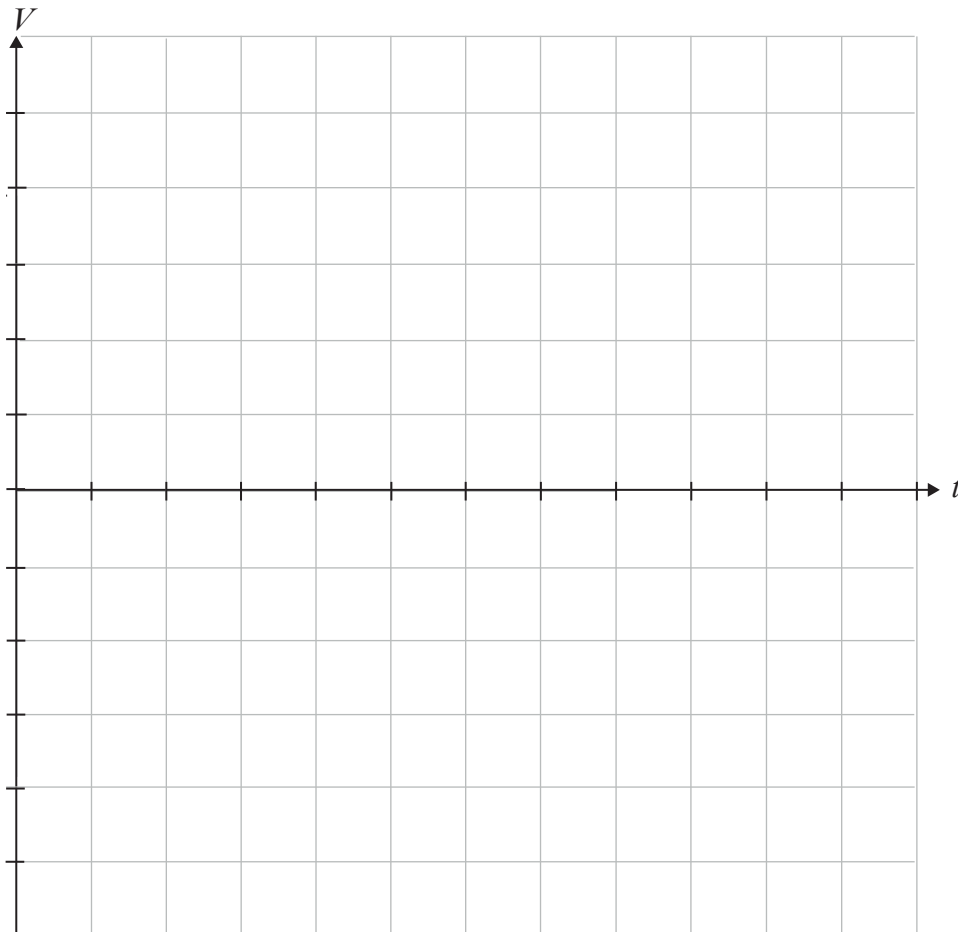
.....
 [1]

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

.....

 [2]

- (iii) On the grid below, sketch the graph of $V = 220\cos t$ for $0^\circ \leq t \leq 360^\circ$.



[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.

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.....
..... [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).

A large rectangular area containing 25 horizontal dotted lines for writing answers. A solid vertical line is on the left side of the page.



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