CAMBRIDGE TECHNICALS

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CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

ENGINEERING

05822–05825, 05873

Unit 1 January 2021 series

Contents

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

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Unit 1 series overview

The topics in this unit underpin all engineering learning. To do well on this paper therefore requires candidates to cover all topics. There was evidence, as in previous series, that LO3 (exponentials and logarithms) and LO5 (calculus) were not covered well; in the assessment up to 35% of the marks could be allocated to these two Learning Objectives.

Candidates who did well on this paper generally did the following:	*Candidates who did less well on this paper generally did the following:*
• Took care with algebra. • Had an understanding of the whole syllabus of the specification.	• Missed out on some topics of the specification.

Question 1 (a)

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

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

This single mark question was universally well done.

Question 1 (b)

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

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

The most efficient approach to solving this equation is to remove brackets and then collect like terms. Most candidates attempted this but for some of them, there were algebraic errors, spoiling the response.

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Question 1 (c)

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

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

This question was constructed to test the remainder theorem, the remainder being the result of substituting x = -1. Very few candidates did it this way, however. The long division approach gave opportunities for algebraic errors.

Question 1 (d) (i)

(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.

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

Those who had studied this topic tended to arrive at the correct answer. A significant minority, however, did not understand that *a* = half the *x* coefficient.

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Question 1 (d) (ii)

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

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

Candidates that answered this question by noting the demand "hence", meaning that what they had done in the earlier part should be used, obtained the correct roots and usually obtained a correct answer. The "otherwise" way was to ignore part (i) and to solve the quadratic equation.

Question 2 (a) (i)

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

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

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

"Show that" requires candidates to write down all their working. Most did so, meaning that the majority of candidates obtained the mark.

Question 2 (a) (ii)

(ii) Factorise $f(x)$.

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

A number of candidates did not appreciate what "factorise" meant but most obtained the correct quadratic factor.

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Question 2 (a) (iii)

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

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

Most candidates either did not complete this question, or made an assumption that if there were more roots then the quadratic factor would factorise further into two terms of the form ($x + a$) where a is a whole number. This is incorrect as it does not cover all possibilities. The only way to demonstrate that there were no further roots was to try to solve the equation taking the quadratic factor = 0. A little easier is simply to show that the discriminant is negative which is a condition for no roots.

Question 2 (b)

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

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

This rearrangement question was usually well done.

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Question 3 (a)

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

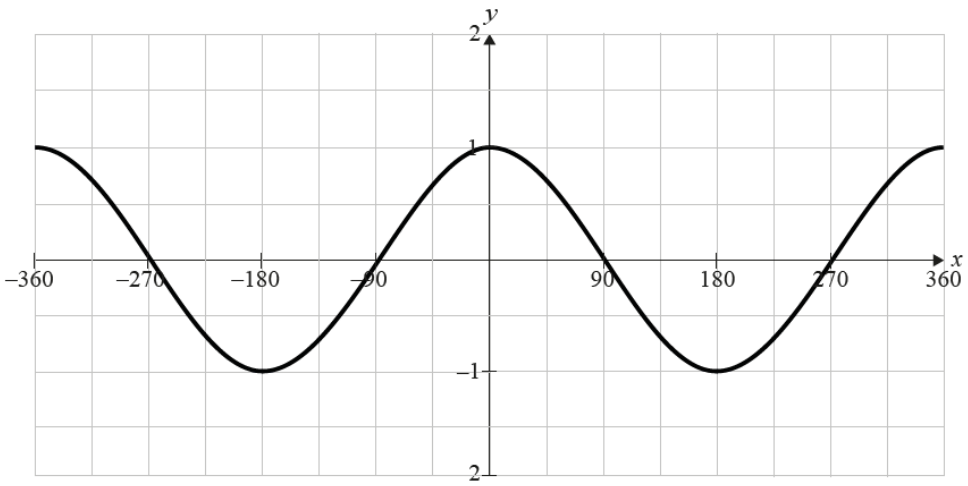

Fig. 1

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

[2]

The sketches were not, in general, good but providing the candidate showed that the range was the same but the period halved, the marks were given.

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Question 3 (b)

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

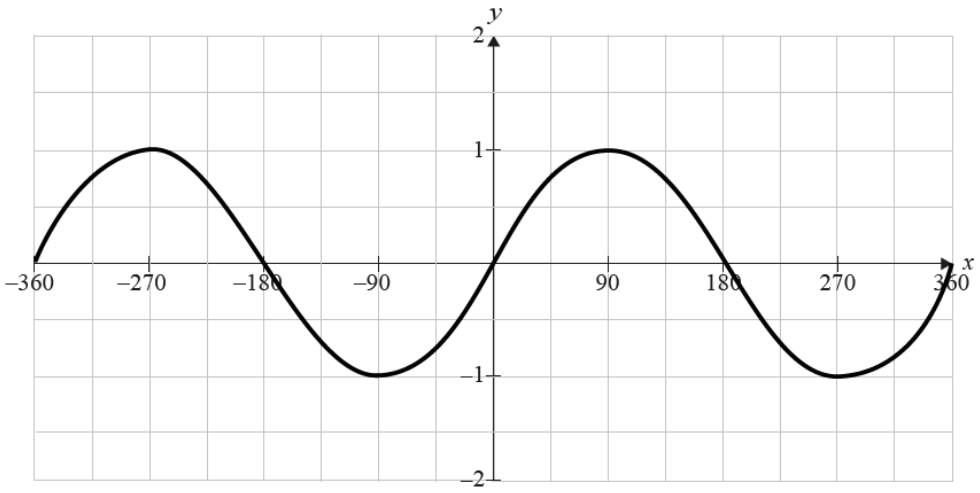

Fig. 2

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

[2]

Most candidates gave a sketch that showed the same shape and most understood that the graph was a translation of 1 unit up the *y*-axis.

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Question 3 (c) (i)

(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.

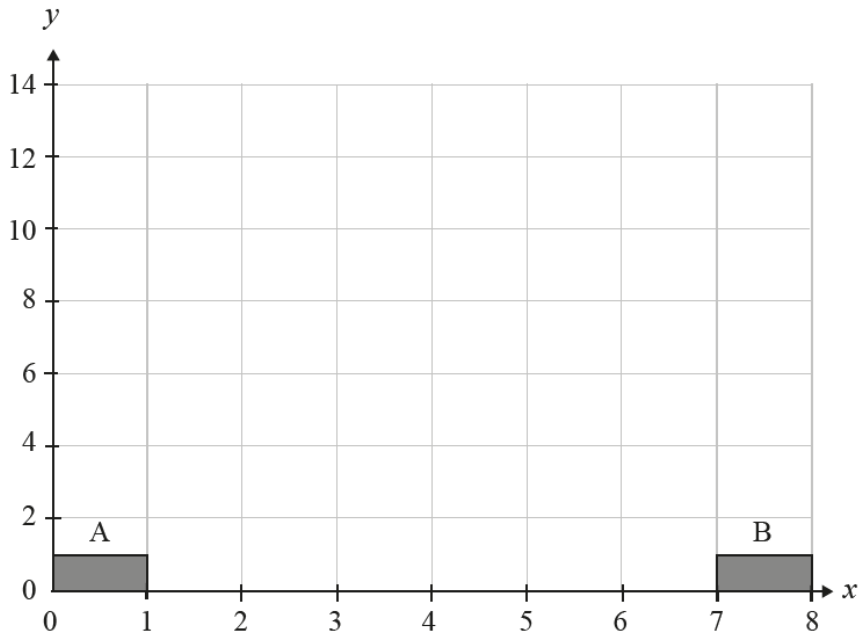

Fig. 3

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]

This sketch was usually well done, though most candidates plotted the curve.

Question 3 (c) (ii)

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

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

Most candidates were able to see that the highest point was on the line of symmetry, at (4, 10).

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Question 4 (a)

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

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

This topic was often not understood. Standard techniques will be assessed and this question expected understanding of the rules of logarithms – in this case $\log x + \log y = \log xy$ and $n\log x = \log x^n$

Question 4 (b) (i)

(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.

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

Most candidates were able to substitute $t = 5$ and calculate the correct answer.

Question 4 (b) (ii)

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

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

Candidates had first to decide what was the initial voltage. Even those that got this wrong were credited for taking logs properly, but this was often not seen. (The point about using logarithms has been made above.)

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Question 5 (a)

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

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

The specification requires candidates to know exact values of the special trigonometrical ratios. A number of candidates did not understand the word "exact".

Key point call out

The word "exact" means that the answer should not be written down from a calculation using the calculator.

Question 5 (b) (i)

(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 $t = 320$.

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

This was done well.

Question 5 (b) (ii)

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

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

The reverse substitution was not so well done with a number of candidates not able to find a value for cos*t*.

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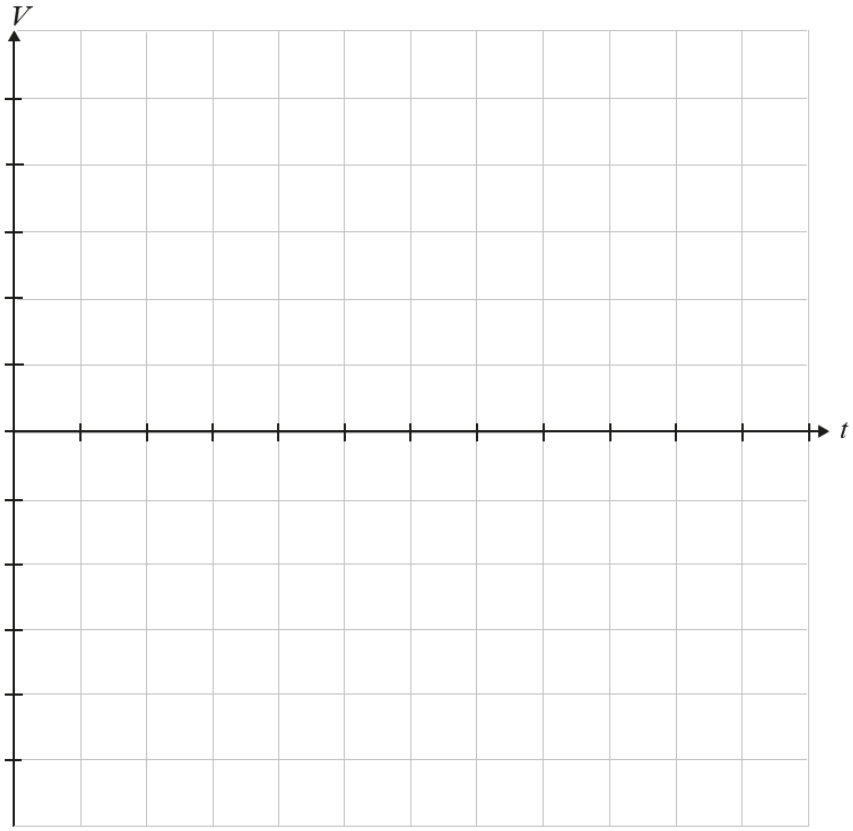
Question 5 (b) (iii)

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



[2]

Candidates first had to decide on scales. While the *t* axis was correct, a number of candidates did not give a linear scale for the *V* axis.

Question 5 (c)

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

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

The cosine formula is given in the formula book, however, a number of candidates did not write it down correctly. Many started with the square of one side as the subject rather than the cosine of an angle as the subject and sadly this led to errors that could have been avoided.

The most frequent error seen here, as in previous years, was taking 4 = 61 – 60cosA to 4 = 1cosA.

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Question 6 (i)

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]**

Calculus is the topic in this specification that causes the most problems. Many candidates could not differentiate. Those that could did not always obtain the correct quadratic to solve.

Question 6 (ii)

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

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

Differentiating a second time caused few problems for those who could differentiate, but rarely did candidates know what to do with it, many setting the second differential equal to zero.

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Question 7 (a) (i)

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?

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

Candidates had to calculate the probability of a machine not failing and then use that with independence to calculate the answer. A good proportion of candidates got this correct.

Question 7 (a) (ii)

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

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

Many candidates got this answer correct, but just as many did not remember the coefficient, resulting in one third of the correct answer.

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Question 7 (b) (i)

(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.

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

The word that was required here was symmetry. Some candidates earned the mark by a long winded way of saying the same thing.

Question 7 (b) (ii)

(ii) Calculate the standard deviation of the data.

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

There are two formulae given in the formula book and each one was used in equal numbers. The main error was in failing to use the frequency. There were 25 items of data and all had to be used to find the standard deviation. A few candidates were able to use their calculator very effectively to give the correct answer.

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