CAMBRIDGE TECHNICALS

OCR
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CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

ENGINEERING

05822–05825, 05873

Unit 1 Summer 2023 series

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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.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Unit 1 series overview

The Unit 1 question paper this series followed the pattern of previous papers and the sample assessment material. The level of demand of the paper was equivalent to previous papers and the candidate response broadly similar.

Although there are six topic areas it is sometimes thought to be helpful to candidates to split the assessment into seven questions as with this paper.

Calculus and exponentials are two topics that candidates traditionally find the most difficult and the responses in this paper indicate that this is still the case.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• have covered the whole syllabus of the specification • were able to follow through a mathematical process logically and clearly.	• lacked confidence in one or more areas of the syllabus • did not respond to questions in one or more topic areas.

Question 1 (a)

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

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

The majority of candidates answered this question well, with only a few making arithmetic and algebraic errors.

Question 1 (b)

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

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

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

There were two main algebraic errors in response to this question. (i) Some did not find the LCM correctly meaning that they had two fractions to add with unequal denominators. (ii) Some took the correct response of $\frac{7x-4}{12}$ and divided only part of the numerator by 4, giving an incorrect response $\frac{7x-1}{3}$

Question 1 (c)

(c) Multiply out and simplify.

$2(x+3y)+3(2x-y)$

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

The vast majority of candidates were able to expand the brackets and collect like terms correctly.

Question 2 (a)

2 **(a)** Solve the equation $x^2+5x-7=0$.

Give your answers correct to 2 significant figures.

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

A significant minority of candidates were unable to solve this quadratic equation. It needed either the formula (given in the formula booklet) or the process of completing the square. For those who have covered this topic there was little difficulty.

The question did ask for roots to be given to two significant figures. When the question does not specify the accuracy required any response of three significant figures or more will be accepted but when a specific number is required, anything else is usually not accepted. In this case the positive root is 1.14…. but since two significant figures was required only 1.1 was accepted.

Key point - approximations

It has been reported already that the rubric on the front page of the question paper requires a degree of accuracy 'appropriate to the context' and that this usually means three significant figures. This is the default requirement unless the question requires a different degree of accuracy. Candidates need to note the general rubric and how alternative demands are given.

In this question the roots of the quadratic equation are required to two significant figures. Candidates should therefore know that if they give their responses to a degree of accuracy which is different from that required then the final mark will not be given.

Question 2 (b) (i)

(b) You are given the cubic function $f(x) = x^3 - 4x^2 + x + 6$.

(i) Show that $f(x)$ can be written as $f(x) = (x+1)(x^2 - 5x + 6)$.

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

A 'show that' question requires all steps in the working to be shown clearly. In this case, multiplying out the two factors to give the given function needed all six terms in the expansion to be seen before collection of like terms. For those attempting long division of the function by (x + 1) all the steps leading to a remainder of 0 had to be seen. In many cases some of the steps were not clear.

Key point – 'Show that…'

In a 'show that' question, the response is given. This has the purpose of allowing a candidate to start the next part of the question with the information needed, even if the first part is not obtained. However, it does place the responsibility on the candidate to demonstrate convincingly that the required response has been legitimately obtained rather than just written down.

Question 2 (b) (ii)

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

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

'Hence' means 'using the information you have' so candidates ought to be aware that part (ii) follows from the information of part (i). Even if candidates cannot complete part (i) successfully they can still use the information given. In this case it is that (x + 1) is a factor and that the division by that factor gives a quadratic function. This question then requires candidates to take that quadratic function given in part(i), factorise it and as a result find the three roots.

Some candidates started again, using the factor theorem to find factors and hence the roots of the equation. Some of these were successful, others less so.

Question 3 (a)

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.

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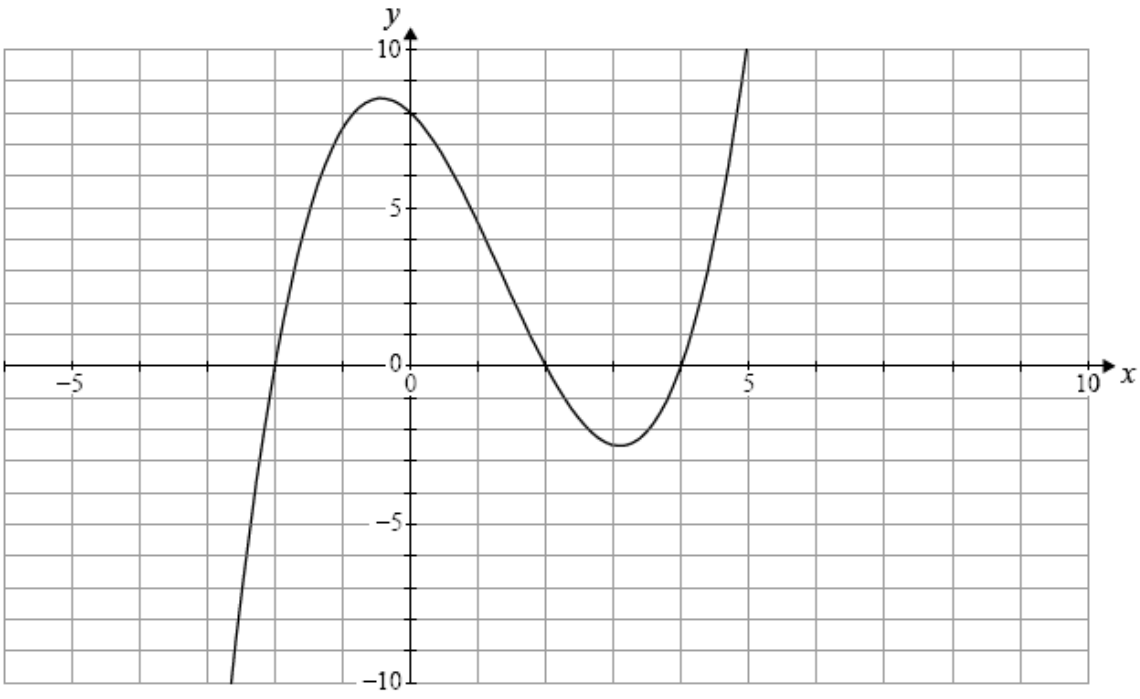
..... **[3]**

The first step, either to take the square root of both sides or taking out the brackets of the right hand side caused the most difficulty. Those that got this right usually finished the rearrangement successfully.

Question 3 (b)

(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]**

The curve to be sketched will be 4 units below the given curve at all points. In this sketch it would have been easy to see integer points on the original curve and count down 4 units in *y*. On many responses seen the points (2, -4), (0, 4), (2, -4), (4, -4) and (5, 6) could be seen to have been marked and the candidates who did so drew an acceptable curve.

Question 3 (c) (i)

(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?

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

The majority of candidates made an acceptable comment about initial values.

Question 3 (c) (ii)

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

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

Candidates who knew how to use their calculator to work with logarithms to base 1.5 had no difficulty with this question, and many who used base 10 obtained the correct response.

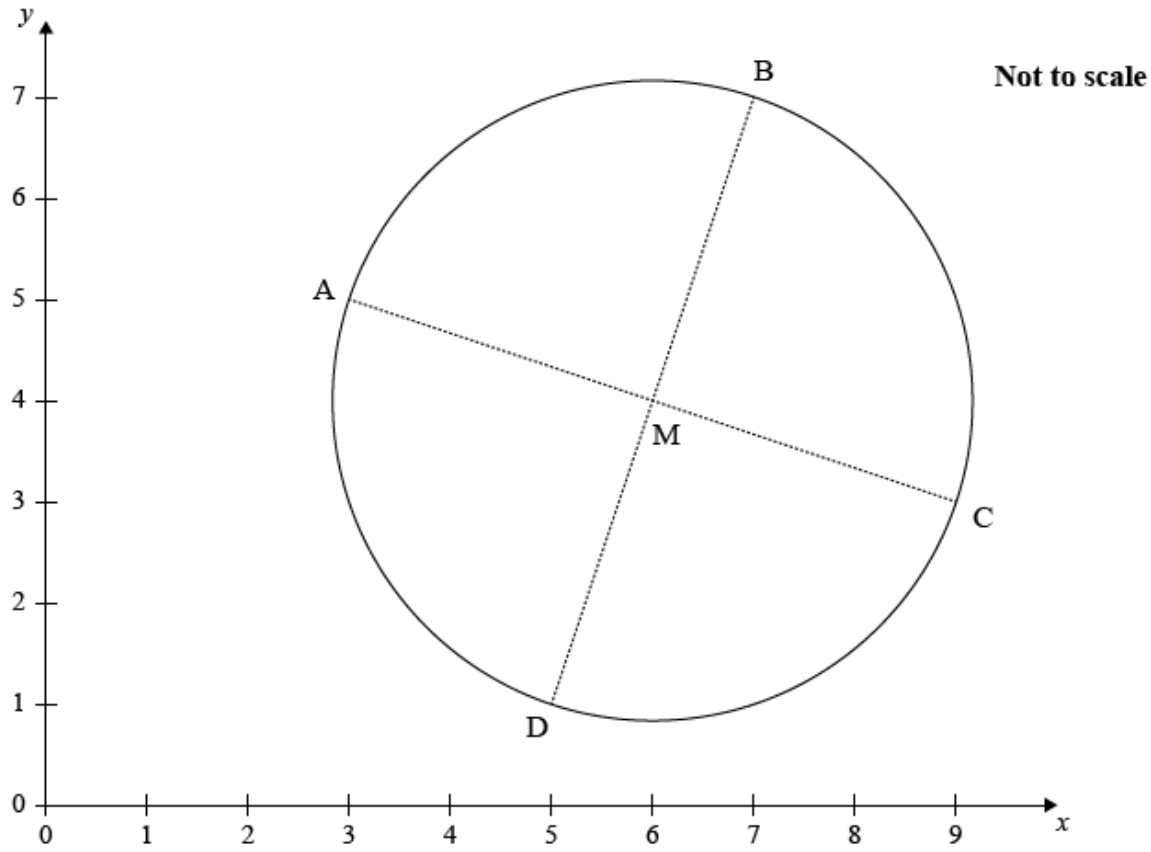
However, a significant majority of candidates did not read the question properly. The four significant figure approximation is 17.04; correcting this to 3 or 2 significant figures was not required – it was the number of complete hours above this response that was required, i.e., 18 hours. Many candidates lost a mark here through not giving their response as the question required.

Question 4 (a)

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.

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

The method that was expected was to find the midpoint by averaging the coordinates. A longer way was to work a vector method and some candidates were unable to complete the question convincingly.

Question 4 (b)

(b) Find the distance AC.

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

A number of candidates were unable to use Pythagoras' theorem to obtain this value.

Question 4 (c)

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

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

Not all candidates knew the general equation for a circle and so were unable to use it in this specific situation. (The general formula is given in the formula booklet.)

Question 4 (d)

(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.

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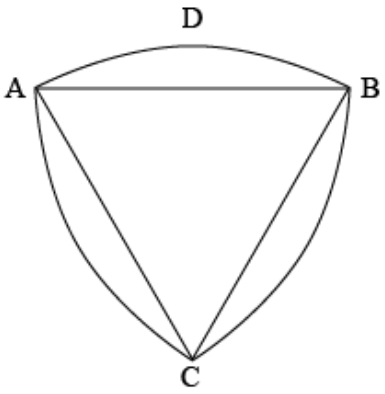
..... **[4]**

While the points B, D and M were marked it was not valid to assume that their coordinates were integer values and so using values read off the graph was not accepted. Rather, the gradient of AC should have been found, followed by the rule for the gradients of perpendicular lines, with the final step using the coordinates of M.

Question 5 (a) (i)

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.

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

Given that ABC is an equilateral triangle the perpendicular height can be found using Pythagoras or that fact that the angles are 60°. A number of candidates thought that the 'half the base times the height' formula meant that the area was $\frac{1}{2} \times 20 \times 20 = 200$

Question 5 (a) (ii)

(ii) the area of the sector CADB.

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

The formula for the area of a sector is given in the formula booklet, but candidates were expected to know that the equilateral triangle has angles of 60°.

Question 5 (b)

(b) Hence calculate the area of the token.

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

There were a number of ways of obtaining the area, all of which were seen, although not always successfully.

Candidates could find the area of one segment by taking their triangle area from their sector area, then taking three of them together with the triangle area. There were combinations of this method seen.

Alternatively, three times their area from part (a)(ii) and subtracting two triangle areas was seen.

Question 6 (a)

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

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

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

The first requirement for this mean value was to take the mid interval for each group, then multiply each by the frequency, adding each result and dividing by 50, the number of bolts.

The most serious error seen was dividing by 4 because there were four groups.

Question 6 (b) (i)

(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]**

The variance is the square of the standard deviation, so this question asked for the square root of 0.64. Many candidates ignored the information of the question and, using their calculators, found the standard deviation of the sample from part (a), more work than was required for the 1 mark.

Question 6 (b) (ii)

(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.

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

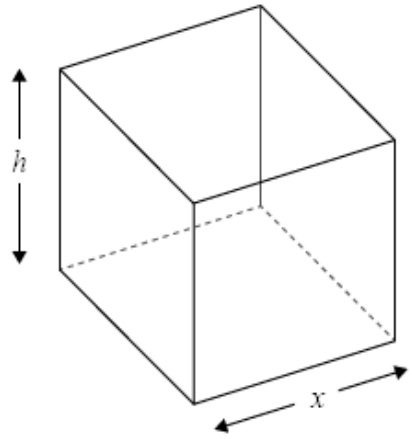
The lower value is below the lowest value from the sample but that did not mean that no length was below the range limit. The upper limit, however, was not outside the range so there would be doubt whether all would be in the range.

Question 7 (a)

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

The volume of the box is V cm^3.

Each side of the base measures x cm and the height h cm as shown in the diagram.



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

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

Most candidates were able to give the formula for the volume of the cuboid.

Question 7 (b)

The volume of the box is to be $4000\,\text{cm}^3$.

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

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

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

This is another 'show that' question where all the steps should be written down correctly. The surface area includes *h* which is found, given the volume, and substituted.

Question 7 (c)

(c) Use calculus to determine the value of x that will give the minimum surface area of the box.

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..... **[5]**

The minimum surface area is found by differentiating the given function (even if it was not obtained) and setting the derivative equal to 0. Many candidates were unable to differentiate a term in *x* with a negative exponent and so the final response was not obtained.

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