CAMBRIDGE TECHNICALS

OCR
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CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

ENGINEERING

05822–05825, 05873

Unit 1 Summer 2022 series

Contents

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

There was a good spread of marks in the Unit 1 paper this series, demonstrating, as in previous years, the fact that some candidates struggle while others do really well.

A key problem is the lack of understanding of some topics within the syllabus, and especially the calculus topics. Differentiation and integration as routine processes may be understood but the application to problems is less well understood.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• tackled all questions with equal confidence • took care over not making unnecessary errors.	• did not understand some of the topics, meaning that some questions could not be accessed • did not use their calculator effectively.

Question 1 (a)

1 **(a)** Multiply out $2(3x - 4y)$.

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

Most candidates completed this part easily, although, some forgot the sign of the second term.

Question 1 (b)

(b) Factorise $x^2 - 7x + 12$.

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

This part was also a source of 2 easy marks. Most candidates were able to write down the expression as two linear factors without showing any working.

Question 1 (c)

(c) Write as a single fraction $\frac{x+2}{4}+\frac{3-x}{3}$.

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

This was also done well with very few candidates being unable to adapt the fractions using the LCM.

Question 1 (d)

(d) Rearrange the following formula so that k is the subject.

$T=2\pi\sqrt{\frac{m}{k}}$

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

This question was not answered well. Where an equation involves a square root sign, the general rule would be square throughout, although many did not do so "throughout", resulting in a first step of

$T^2=2\pi\times\frac{m}{k}$

Question 2 (i)

2 You are given the cubic function $f(x) = x^3 - 6x^2 + 11x - 6$.

(i) Show that $f(2) = 0$.

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

This is a "show that" question. This means that every step should be shown to demonstrate to the marker that all the steps have been worked through to the end result. There are occasions where a candidate gets lost in the process so just writes down the result that has been given. So, all candidates understood that f(2) meant a requirement to substitute x= 2, but many did not demonstrate that they had done the arithmetic step, writing $2^3 - 6\times 2^2 + 11\times 2 - 6 = 0$. The failure to write in the arithmetical step meant that there was no indication that they knew that 2^3 = 8. Some who did write in this step wrote that $6\times 2^2 = 144$ and still managed to assert that the result was 0.

Question 2 (ii)

(ii) Hence factorise $f(x)$.

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

Part (i) is a hint that (x – 2) is a factor. Candidates who understood that, were able to make good progress to finding 3 linear factors. Others got there by obtaining (x – 1) by trial.

Question 2 (iii)

(iii) Solve the equation $f(x) = 0$.

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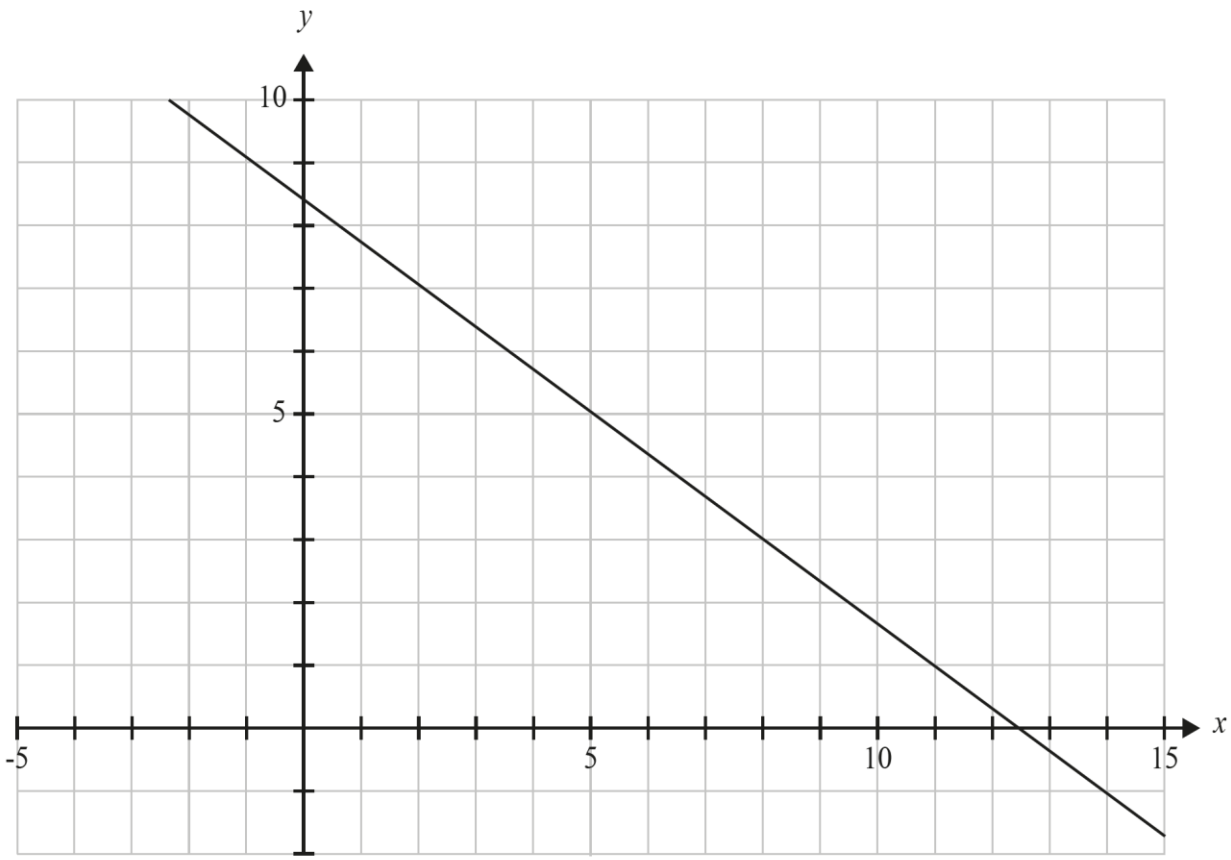
..... **[1]**

A proportion of candidates were confused between factors of an expression and roots of an equation. So, some candidates did not complete these questions although they had part (ii) correct. Others had written the response to this part in part (ii) so did not know what to do here.

Question 3 (a) (i)

3 **(a)** The graph of the line $2x + 3y = 25$ is shown on the grid below.



(i) On the same grid plot the line with equation $y = 3x + 1$. **[2]**

The line was usually drawn correctly, the most frequent error was the drawing of the line through (0, 1) with gradient $\frac{1}{3}$.

Question 3 (a) (ii)

(ii) Hence write down the solution to the simultaneous equations $y = 3x + 1$ and $2x + 3y = 25$.

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

Candidates were being challenged here to realise that the solution to these simultaneous equations was the intersection of the two lines in part (a)(i). The word "hence" should be understood as "using the information you have..." So, the "correct" response to this question was the coordinates of the point of intersection of the lines, even if that was wrong. Solving the equation algebraically earned no credit.

Question 3 (b) (i)

(b) A cylinder has a radius r cm and height h cm.
The surface area is given by the formula $A = 2\pi r^2 + 2\pi rh$.
A particular cylinder has height 12 cm and a surface area 300 cm^2.

(i) Show that the radius satisfies the equation $3.14r^2 + 37.7r - 150 = 0$ where the coefficients are given to 3 significant figures.

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

A number of candidates misunderstood this question, asked themselves what the radius is and realised that it was required in the next part. So, part (b)(ii) was completed, and the value found substituted into this earlier part to show that the value satisfied the equation.

Those that realised that this was not the correct route to take (for otherwise the two parts would have been the other way round!) were able to substitute values of A, h and π into the given formula and manipulate it to give what was required.

Question 3 (b) (ii)

(ii) Use the quadratic formula to solve this equation to find the radius of the cylinder.

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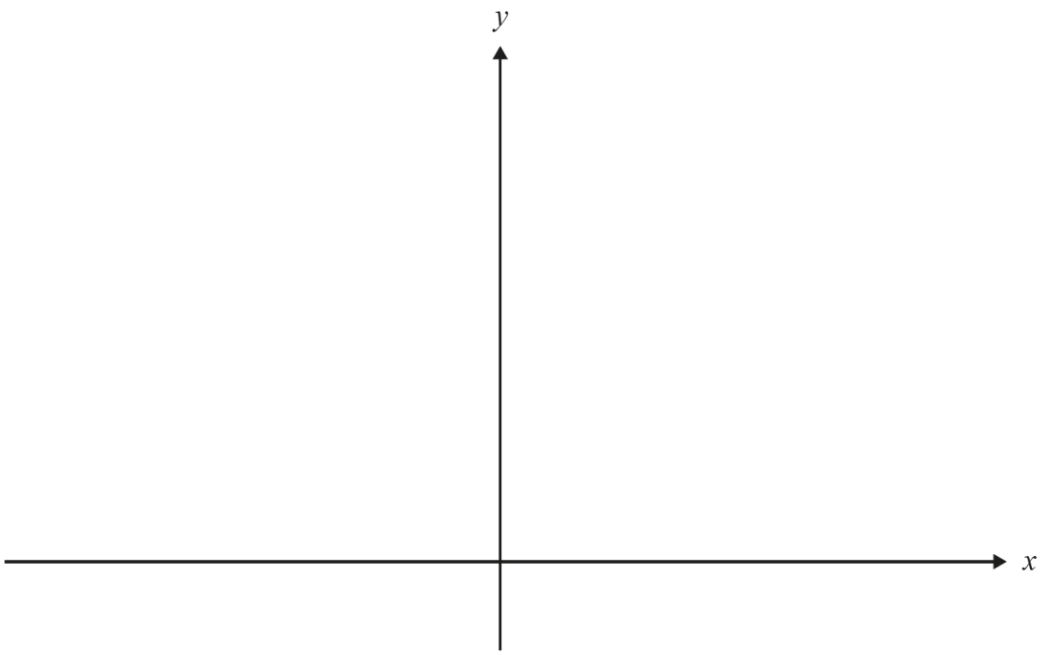
..... **[3]**

A majority of candidates were able to use the quadratic formula, given in the formula booklet, to find values for *r*. However, the question did not stop at requiring the roots of the equation but to give a value for *r*. One of the roots of the equation is negative and so an invalid value for a practical problem needs to be rejected, or at least ignored. Those that gave two values, of which was negative, as the response to this question lost the final mark.

Question 4 (a)

4 **(a)** On the grid below, sketch the graph of $y = (x - 2)^2 + 3$.



[2]

The quadratic function was written in this way deliberately to encourage candidates to realise that it was a quadratic with minimum value of 3 occurring when x = 2. Unfortunately, most candidates did not "see it" this way. A significant number did sketch a parabola that was the right way up, but the minimum value was rarely correct. Additionally, no scales were given so they had to include those to be able to identify the minimum at (2, 3).
A small minority chose to plot the curve, thus demonstrating a lack of understanding of the difference between a plot and a sketch.

Question 4 (b) (i)

(b) On the grid below, sketch

(i) the graph of $y = 2\cos x$ for $0° \leqslant x \leqslant 360°$, **[2]**

The freehand sketch of the graph is not easy and so generous allowances were made. The crucial parts were (i) the range, which is [-2,+2], (ii) $y = 2$ when $x = 0^0$ and 360^0 and (iii)a curve indicating a "flattening off" at $x = 0^0$ and 360^0. Straight lines were not acceptable and more than one period also not acceptable unless the scale indicated clearly that the curve was being sketched for values beyond 360^0

Question 4 (b) (ii)

(ii) the graph of $y = 2 + 2\cos x$ for $0° \leqslant x \leqslant 360°$. **[1]**

Whatever the curve was in Question 4(b)(i) credit was given for a curve (or a series of straight lines) that was consistently (as far as freehand drawing allowed) 2 units above the first curve. In some cases, this curve bore little relationship with the original curve.

Question 4 (c) (i)

(c) You are given that $\sin x = p$ where $-1 \leqslant p \leqslant 1$.

Find expressions for

(i) $\sin(-x)$,

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

Most candidates did not understand what was required here by asking for an expression. Only a small minority of candidates wrote the correct response.

Question 4 (c) (ii)

(ii) $\cos x$.

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

This part was answered correctly by only a handful of candidates, demonstrating that few candidates understood the relationship between cos*x* and sin*x*.

Question 5 (a)

5 **(a)** Use calculus to determine the coordinates of the stationary point on the curve $y = x^2 - 4x + 7$.

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

Calculus is the topic that is least well known, and few candidates achieve full marks from these questions. Most candidates understood that the function should be differentiated but this was usually not well done. Setting the gradient function to 0 was a step that most candidates missed.

Question 5 (b) (i)

(b) The voltage growth in a capacitor can be modelled by the formula

$V = 12\left(1 - e^{-\frac{t}{4}}\right)$

where V is the voltage t seconds after the application of current through the circuit.

(i) Calculate the voltage in the capacitor after 5 seconds.

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

Most candidates could feed the necessary calculations into their calculator to achieve the correct response.

Question 5 (b) (ii)

(ii) Calculate the time taken for the voltage to reach 7 V.

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

Carrying out the reverse process however was much less well done. Many achieved an approximate response by trial and improvement, but the standard process of taking logarithms was not tackled well.

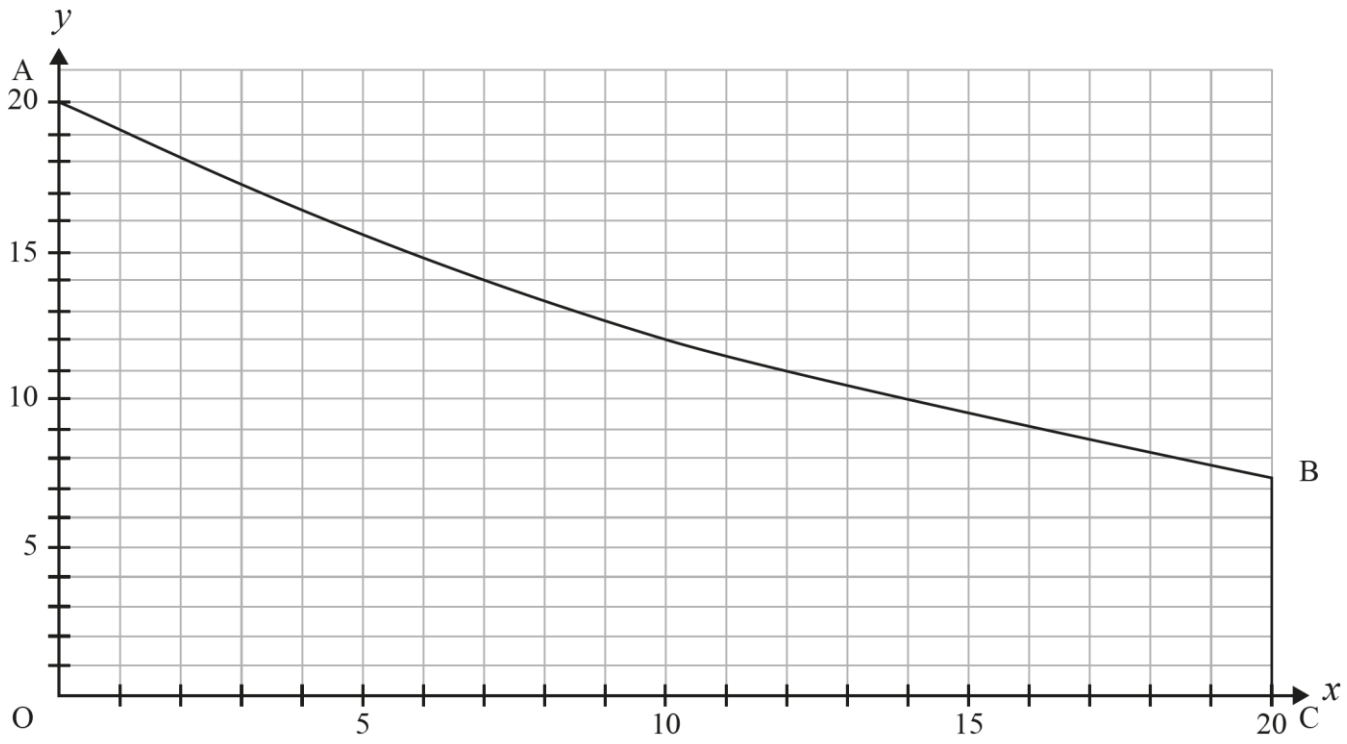
Question 5 (c)

(c) A metal plate, OABC, has three straight edges and one curved edge.

On a coordinate system, O is the origin and the coordinates of A and C are (0,20) and (20,0) respectively.

The curved edge, AB, has equation $y = 20e^{-\frac{x}{20}}$ as shown in the diagram.

Units are millimetres.



Using calculus, calculate the area of the metal plate.

Give the units of your answer.

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

The area under the curve requires integration. Of the candidates that knew the process, few could manage the integration of an exponential function. A significant number tried an approximate method, but none were accurate enough. A response obtained from a calculator was acceptable.

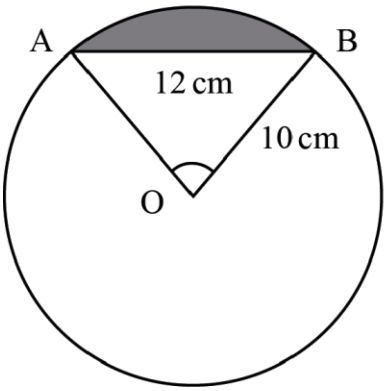
Question 6 (i)

6 A component of a machine is part of a circle which has radius 10 cm.

Two points, A and B, on the circumference of the circle are 12 cm apart, as shown in **Fig. 1**.

The centre of the circle is O.

The component has a section of the circle above the line AB removed. This section is shown shaded in **Fig. 1**.



Not to scale

Fig. 1

(i) Find the angle AOB, giving your answer in degrees.

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

Most candidates tackled this question using the cosine formula, but not always successfully. Some found the wrong angle. Others made the error of carrying out operations in the incorrect order, such as $a^2 = \left(b^2 + c^2 - 2bc\right)\cos A$.

Others worked the triangle with a dropped perpendicular to find half the required angle. A number did not find the correct angle and gave the angle at A or B.

Misconception

The correct order of equations

$12^2 = 10^2 + 10^2 - 2\times10\times10\times\cos\theta \Rightarrow 144 = 200 - 200\cos\theta$. Candidates should now make $\cos\theta$ the subject of the formula

i.e., $\cos\theta = \dfrac{200-144}{200} = 0.28 \Rightarrow \theta = 73.74^0$

A common error in this use of the cosine formula gives $144 = 200 - 200\cos\theta \Rightarrow 144 = (200 - 200)\cos\theta$ which cannot be solved.

Question 6 (ii)

(ii) Hence find the area of the shaded section removed from the circle in **Fig. 1**.

Give the units of your answer.

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

The majority of candidates understood that they need to find the area of the sector and subtract the area of the triangle. A few candidates were confused over whether they were working in radians or degrees and while others were working with the wrong angle obtained in part (i)

Question 7 (a)

7 **(a)** It is known that a particular component in a machine has a probability of failing in the first day of use of 0.2.

If the component fails then the machine fails.

What is the expected number of machines that will fail on the first day in a batch of 50 machines?

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

Most candidates understood the idea of expectation and were given full marks.

Question 7 (b) (i)

(b) In a bag there are 20 blue balls and 20 red balls, all identical except for their colour.

Two balls are drawn at random from the bag and their colour noted.

Find the probability that both balls will be red if

(i) the first ball is replaced before the second ball is drawn,

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

This was also a source of 2 marks, even for the less able candidates.

Question 7 (b) (ii)

(ii) the first ball is not replaced before the second ball is drawn.

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

A slightly trickier question but many succeeded in finding the probability.

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