CAMBRIDGE TECHNICALS

OCR
Oxford Cambridge and RSA

CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

ENGINEERING

05822–05825, 05873

Unit 1 January 2023 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

This cohort of candidates performed in line with previous cohorts and many did well. There are many places where arithmetic or algebraic errors occur and most candidates suffered the loss of a mark or two because of this.

Many candidates are unable to perform well in some topic areas, in particular, calculus and logs and exponentials.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• were able to access all questions with confidence • were careful not to make arithmetic or algebraic errors • were able to use their calculator with confidence.	• were unable to access all questions through lack of knowledge of the subject • were not confident in algebra or arithmetic • were not confident in the use of their calculator.

Question 1 (a)

1 (a) Factorise $6x - 4$.

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

While the vast majority of candidates were able to start this paper with an easy mark many were unable to understand how to do this question.

Question 1 (b)

(b) Multiply out $(2x + y)^3$. Your final answer should be in simplified form.

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

Many candidates were able to use the binomial expansion to write out the expanded answer quite easily. A significant number multiplied out two brackets first and then multiplied their result by the third bracket. While a perfectly acceptable approach, it did provide more opportunities to make algebraic and arithmetic errors.

Question 1 (c)

(c) Determine the quotient and the remainder when $x^3 - 5x^2 + 6x - 3$ is divided by $x - 2$.

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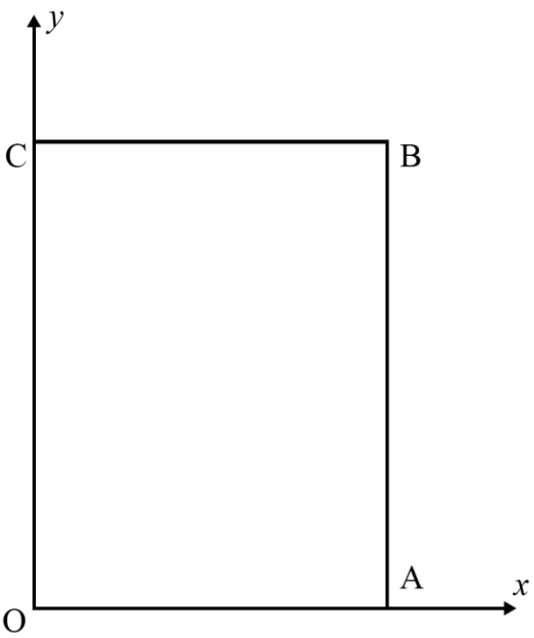
..... **[3]**

The factor theorem was used by some candidates, but this only found the remainder, for which a mark was given. Long division was the preferred route but many made algebraic errors.

Question 2 (i)

2 On a rectangular plate OABC a coordinate system is placed. O is the origin (0,0). A and C have coordinates (7,0) and (0,8) as shown in the diagram.



(i) Find the coordinates of M, the midpoint of OB.

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

There was usually no difficulty in finding the midpoint, although some got there by an incorrect method – e.g. $\left(\frac{x_1 - x_2}{2}, \frac{y_1 - y_2}{2}\right)$ rather than $\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$

Question 2 (ii)

(ii) Find the equation of the line AC.

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The main difficulty here was finding the gradient but most candidates obtained the correct equation.

Question 2 (iii)

(iii) Confirm that point M lies on the line AC.

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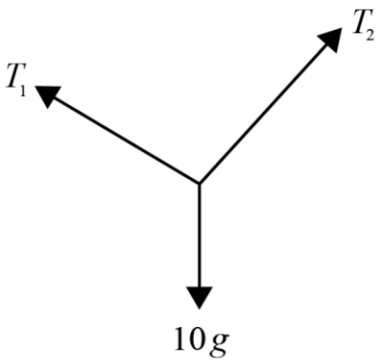
..... **[1]**

The main method was to take the coordinates from part (i) and substitute them into the equation of part (ii). A geometric argument was accepted providing it was given in full – i.e. stating that OABC was a rectangle and then the property that diagonals of a rectangle bisect each other.

Question 3 (a)

3 (a) A weight of 10 g N is suspended by two ropes as shown in the diagram. The tensions in the ropes are T_1 and T_2 respectively.



In this situation you are given that the forces obey the following equations.

$$9T_1 = 5T_2$$

$$5T_1 + 9T_2 = 1000$$

Find the values of T_1 and T_2.

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In spite of the way that the two equations were set out in the stem, many candidates did not realise that this was a question involving simultaneous equations. Those that did generally had no difficulty in obtaining the correct values for T_1 and T_2.

Question 3 (b)

(b) Solve the equation $x^2 + 3x - 28 = 0$.

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

There are two ways to solve this equation – by factorisation or by using the formula. Many candidates chose the latter. This introduced opportunities for arithmetic errors. Those that looked for factors generally obtained the correct roots without difficulty, although some had -4 and 7 rather than 4 and -7.

Question 3 (c) (i)

(c) You are given that $f(x) = 2x^2 - 16x + 15$.

(i) Write $f(x)$ in the form $f(x) = 2(x+a)^2 + b$.

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

This question was not answered well by the majority of candidates. Most realised that they had to extract a factor of 2. Many divided the whole expression by 2, carried out the completion of the square and then multiplied their answer by 2. This was a neat way to solve the problem, but necessitated dividing the whole expression by 2 and then, when the result $(x-4)^2 - 8.5$ was obtained, multiplying both terms by 2. Many did not carry out the division and subsequent multiplication by 2 correctly. Others took out the 2 as a factor of the first two terms, giving $2(x^2 - 8x) + 15$ but then seemed unable to complete the square on $(x^2 - 8x)$.

Question 3 (c) (ii)

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

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The candidates who had written the expression in Question 3 (c) (i) correctly obtained the result easily. Others ignored their attempts in the earlier part and solved the quadratic equation using the formula.

Question 4 (a)

4 (a) Write the following as a single logarithm.

$\log x^2 + \log 2 - \log x$

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

Questions involving logarithms often cause problems for candidates. Few responses to this question demonstrated an understanding of the main log laws -

$\log x^n = n\log x, \log x + \log y = \log xy$ and $\log x - \log y = \log\left(\frac{x}{y}\right)$.

Many obtained a correct result except that they did not reduce their fraction to its lowest terms.

Question 4 (b)

(b) When a capacitor is charged through a resistor in an electrical circuit the voltage, V, at time t seconds, is given by the formula $V = V_s\left(1 - e^{-\frac{t}{RC}}\right)$. C is the capacitance, R is the resistance and V_s is the applied voltage.

In a circuit there is a resistor of $5000\,\Omega$ and a fully discharged capacitor of $0.0008\,F$. A voltage of $12\,V$ is applied to the circuit.

Calculate the time in seconds when the voltage across the capacitor has reached $11\,V$.

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

This seemed to be a well known formula and $RC = 4$ was often obtained when no other mark was given. Some switched V with V_s leading to an impossible equation. Generally, proceeding to the result by using logs defeated most.

Question 5 (a)

5 **(a)** A wheel is rotating at 10 revolutions per minute.

Express this in radians per second.

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

Those that worked entirely in radians achieved the correct answer. The majority of those who worked first in degrees (i.e. 10 revs = 3600^0) slipped up by dividing by $\frac{\pi}{180}$ instead of multiplying.

Question 5 (b) (i)

(b) A piece of wood, ABC, is triangular in shape. AB = 8 cm, BC = 3 cm and CA = 7 cm.

(i) Calculate the angle ABC.

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Many candidates knew, and could use, the cosine formula well. However, very few could write down the formula where $\cos B$ is the subject. This means that when finding an angle, some algebraic or arithmetic manipulation is required and this introduces errors. The most prolific error is to substitute correctly to give $49 = 73 - 48\cos B$ and then to write $49 = 25\cos B$ for which there is no solution.

A number of candidates correctly found one of the other angles.

The cosine formula

There are two common errors seen in questions involving the cosine formula, both in the arithmetic manipulation. The formula booklet gives the formula $a^2 = b^2 + c^2 - 2bc\cos A$. In questions where the calculation of an angle is required (e.g. when all three sides are given) some rearrangement is required either before the candidate starts the question, giving $\cos A = \dfrac{b^2 + c^2 - a^2}{2bc}$ or during the course of manipulation. In this case $a^2 = b^2 + c^2 - 2bc\cos A$ becomes $a^2 = \left(b^2 + c^2 - 2bc\right)\cos A$. The substitution of the correct values will give an incorrect answer; in this case it will give an impossible value for $\cos A$ *(*$\cos A = 49/25$*)*. Candidates need to be familiar with the process of algebraic manipulation or the dangers of carrying out arithmetic manipulation in the wrong order of the operations.

Question 5 (b) (ii)

(ii) Calculate the area of the wood. Give the units of your answer.

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

It was possible to earn full marks here using the wrong angle found in part (b) (i). Most candidates who got a correct angle for the triangle found the area correctly.

Question 6 (a) (i)

6 The management of a company that assembles components analysed the work completed by each employee.

(a) They recorded the number of components assembled by each employee in one particular hour.

The data are as follows.

12	14	18	11	13	13	11	17	16	13
18	17	12	15	16	17	12	11	17	14

(i) On the table below complete a tally of these data.

Number of components	Tally	Total
11		

[2]

It was rare to see an incorrect tally but a number of candidates did not sum their tally. For instance there are three entries of 11 in the data and candidates put /// in the tally cell but decided that they had to multiply this by 11 to give in the total column 33 rather than 3.

Question 6 (a) (ii)

(ii) Write down the mode of these data.

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

The vast majority of candidates knew what the definition of "mode" is and so earned the mark.

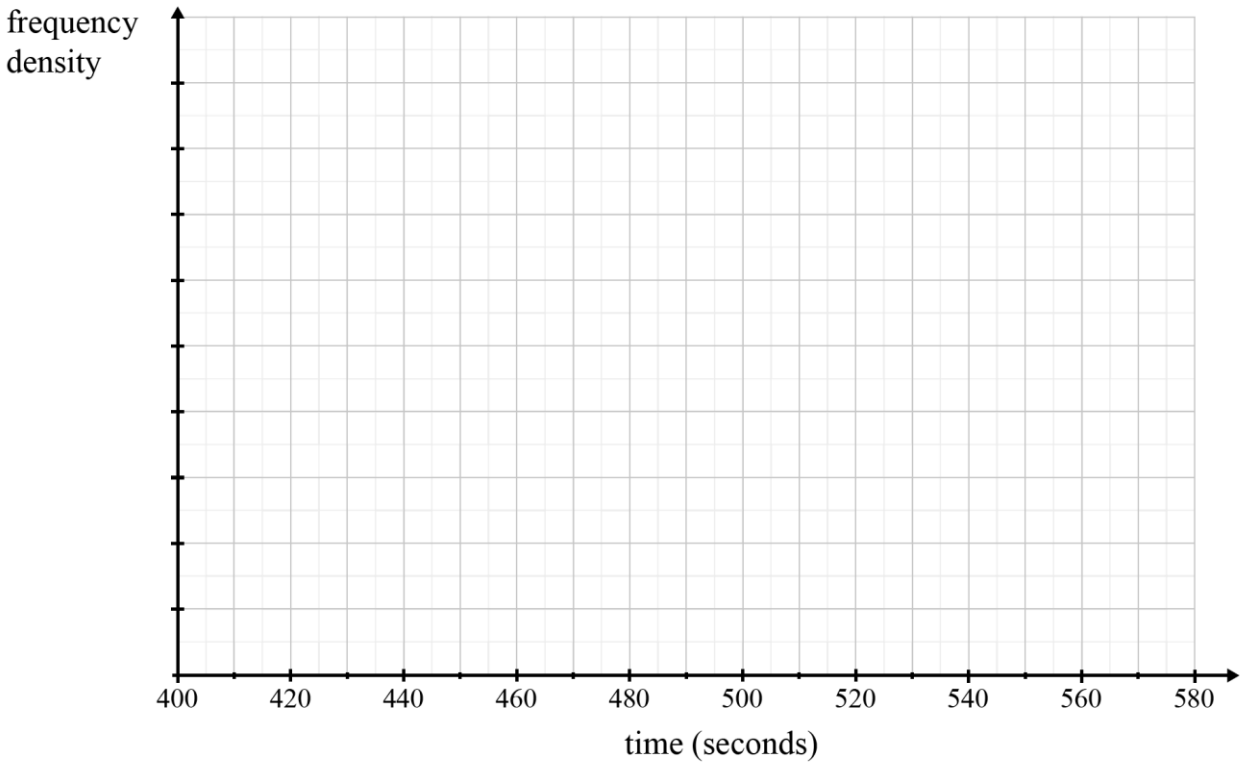
Question 6 (b) (i)

(b) They recorded the time, t seconds, that each employee took to complete the assembly of two components.

The data are summarised as follows.

Time (t secs)	$440 \leqslant t < 460$	$460 \leqslant t < 480$	$480 \leqslant t < 500$	$500 \leqslant t < 540$
Frequency	4	8	6	2

(i) On the grid below, draw a histogram of these data.



[4]

The majority of candidates did not understand fully how to draw a histogram. So while the bars were drawn with the correct width, the fact that it is the area of the bar rather than the height that records the frequency was missed.

Question 6 (b) (ii)

(ii) On your histogram draw a frequency polygon to display the data. **[2]**

The frequency polygon was not always drawn through the midpoints of the top of each bar.

Question 7 (a)

7 (a) Find $\int \cos 2x \, dx$.

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A few candidates differentiated rather than integrated. Being an indefinite integral an arbitrary constant is needed in the answer, which some candidates missed.

Question 7 (b) (i)

(b) A particle moves on a straight line through a point O such that its velocity, v metres per second, at t seconds is given by the formula $v = 4t - t^2$.

(i) Find the time at which the acceleration is zero.

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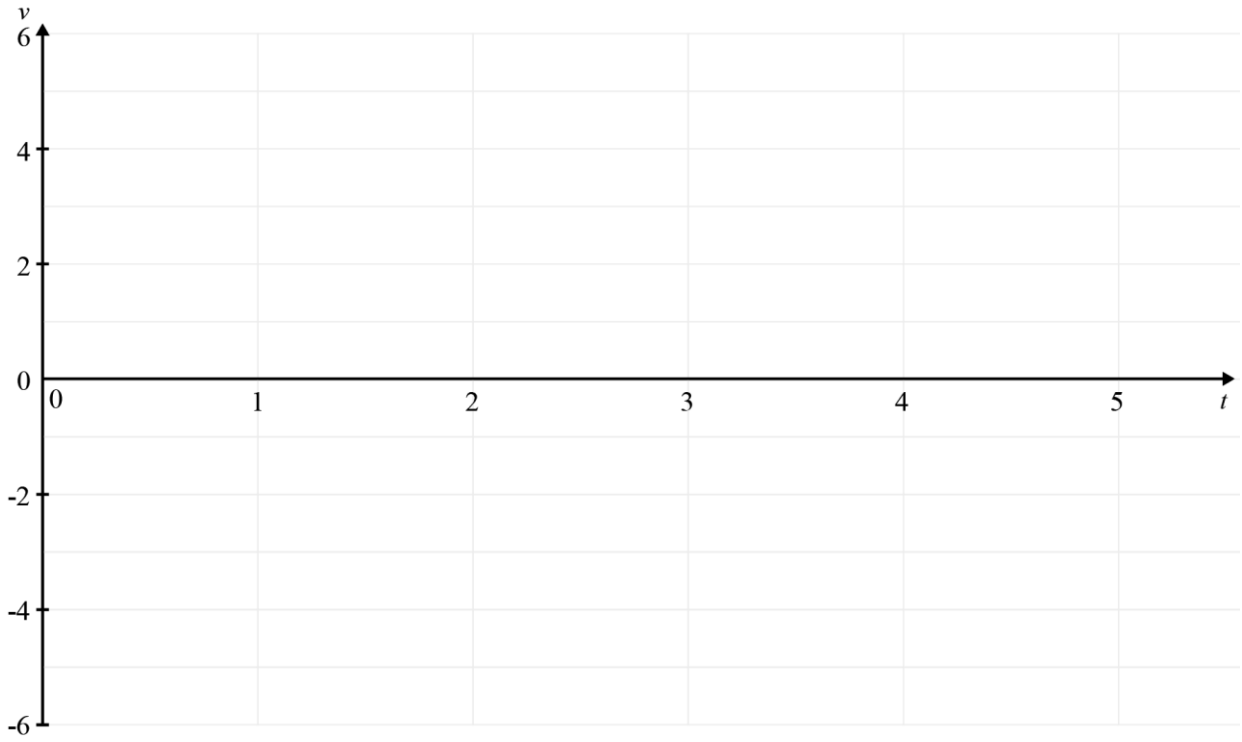
A number of candidates did not realise that in order to find an expression for the acceleration, the velocity function need to be differentiated. A number misunderstood the question and found the time when the velocity was zero.

Question 7 (b) (ii)

(ii) On the grid below, sketch the graph of v against t for $0 \leqslant t \leqslant 5$.



[2]

Most candidates do not sketch graphs, but instead they plot by calculating coordinates that satisfy the equation. Some then join the points with straight lines. The candidates who knew that the equation was a quadratic, with a negative coefficient for t^2, sketched the graph for an inverted parabola.

Question 7 (b) (iii)

(iii) Given that the total distance travelled in the first 4 seconds of motion is given by the area between the curve, t-axis and the line $t = 4$, calculate this distance.

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Most candidates realised that integration was required here and many obtained the correct result. Attempting to find the area by a numerical method invariably resulted in an answer that was not accurate enough for full marks.

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