CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

ENGINEERING

05822–05825, 05873

Unit 1 Summer 2019 series

Version 1

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 exam paper can be downloaded from OCR.

Paper Unit 1 series overview

This report is on the performance of candidates for Cambridge Technicals in Engineering, Level 3, Unit 1 – Mathematics for engineering.

The specification covers six topics in Mathematics. The proportion of marks assigned to each learning outcome is not uniform; Candidates should therefore expect to see roughly twice as many marks assigned to topics in algebra as in other topics. However, all topics will be covered in accordance with the weightings given in the Unit Specification. In order to do well in this paper, therefore, candidates should be taught all the topics.

In this paper, as in previous years, questions on exponentials, logarithms and calculus were generally answered rather poorly.

Question 1 (a)

1 (a) Multiply out the brackets and simplify

$$3(3x+2)-2(x+1).$$

....

....

.... **[2]**

The majority of candidates were able to perform this algebraic simplification correctly. Of those who lost marks, most obtained B1 from simplifying the x terms correctly to achieve 7x. A large number of candidates were not able to deal with the negative sign between the brackets achieving 7x + 8 as their final answer.

Question 1 (b)

(b) Rearrange the formula $v = u + at$ to make t the subject.

....

....

.... **[2]**

Candidates were generally very successful at making *t* the subject of the equation.

Question 1 (c)

(c) Write $x^2 - 4x + 7$ in the form $(x-a)^2 + b$ where a and b are integers to be determined.

....

....

.... **[2]**

When completing the square, plenty of candidates were able to obtain the correct bracketed terms. However it was often followed up with +7

Question 2 (a)

2 **(a)** A piece of wire has a length of 68 cm. It is cut into two pieces so that the longer piece is three times as long as the shorter piece.

Let the length of the shorter piece be x cm. Form an equation in x and solve it to find the length of each piece.

....

....

....

.... **[3]**

The question was attempted by a significant number of candidates and the majority were able to form an equation in x or work with the numbers in order to obtain the expression for length of the shorter piece. Surprisingly, many did not continue on to state an expression the larger piece.

Question 2 (b) (i)

(b) Resistance thermometers are affected by their temperature according to the law

$$R = R_0 + k\theta$$

where R_0 is the resistance at 0 °C , R is the resistance at θ °C and k is a constant known as the temperature coefficient of resistance.

(i) For one type of thermometer $R_0 = 200$ and $R = 203$ at 21 °C. Find the value of k for this resistor.

....

....

....

.... **[2]**

Candidates were quite good at substituting the values into the given formula and obtaining the fractional or decimal value of k.

Question 2 (b) (ii)

(ii) For a different thermometer the resistance $R = 205$ at 40 °C and $R = 203$ at 20 °C. Write down two equations in R_0 and k. Solve them simultaneously to find the values of R_0 and k.

....

....

....

....

....

.... **[3]**

Candidates were relatively successful at setting up equations, although many were unable to identify that they were simultaneous equations and so often did not provide a solution. Some confused R and R0 and substituted the values incorrectly. There were some candidates who assumed the k value from part (b) had to be used and so this would then obtain the wrong value for R_0.

Question 3 (a) (i)

3 **(a)** **(i)** Write down the exact value of sin60°.

.... **[1]**

Despite requesting an exact value, quite a few candidates still just gave the decimal equivalent. The specification requires candidates to know exact values.

Question 3 (a) (ii)

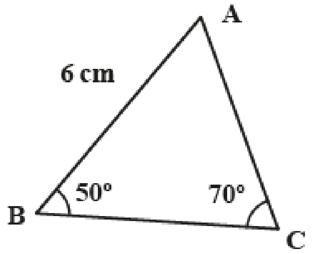
(ii) Find cos112°, giving your answer correct to 3 significant figures.

.... **[1]**

A very large number of candidates achieved the mark for this question. However some candidates ignored the instructions and incorrectly rounded to –0.38.

Question 3 (b) (i)

(b) In the triangle ABC, AB = 6 cm, angle B = 50° and angle C = 70°.



Not to scale

(i) Use the sine rule to find the length of AC.

....

....

....

....

.... **[3]**

Candidates were given the instructions to use the sine rule with the majority knowing how this needed to be structured. The correct answer was often achieved. A significant proportion of candidates, however, found the length of the wrong side.

Question 3 (b) (ii)

(ii) Find the area of the triangle ABC.

....

....

....

....

....

.... **[3]**

(ii) Attempts at this part were often less successful. It required candidates to obtain the missing angle in the triangle and use their answer to find the area using the formula

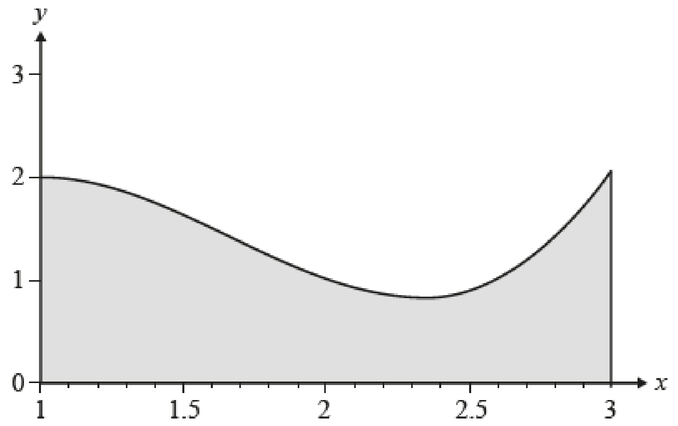
$\text{Area} = \frac{1}{2}ab\sin C$. Some candidates recognised that the third angle of the triangle was 60° with little or no working in part (ii) as they had added it to their diagram in part (i). Some candidates chose to split the triangle into two parts, finding the height by trigonometry and then finding the area of the two parts; this approach had varying degrees of success. Often the wrong angle or sides were used in the right equation leading to no method or accuracy marks being given. A particular problem was the inability to 'see' the height as the length from one vertex to the opposite side. Those who felt that the height had to be a 'vertical' line up the page experienced difficulty in completing this part.

Question 4 (a) (i)

4 **(a)** A trough has cross-sectional shape given by the equation

$$y = x^3 - 5x^2 + 7x - 1$$

together with the x-axis and the lines $x = 1$ and $x = 3$. Units are in metres.



(i) Find the area of the region between the curve, the x-axis and the lines $x = 1$ and $x = 3$.

....

....

....

....

....

....

.... **[4]**

Candidates were not very successful in finding the area and often substituted the limits directly into the unchanged equation, while some differentiated first. Those who did integrate often went on to achieve most or all of the marks. Some candidates did not achieve the final mark by not stating units on their answer. These were needed for the accuracy mark. Candidates should be aware that approximate methods, such as drawing rectangles, will not find the area but only an approximation to it. Approximation of definite integrals using numerical methods is not part of this specification.

Question 4 (a) (ii)

(ii) The trough is a prism with a length of 2 metres.

Find the volume of the trough.

....

....

.... **[1]**

Although most candidates did not achieve the area in part (i) a very large number benefitted from multiplying their area by 2.

Question 4 (b)

(b) The displacement, s metres, of a car is given by the formula $s = 2t + t^3$.
Using differentiation, find the velocity after 3 seconds.

....

....

....

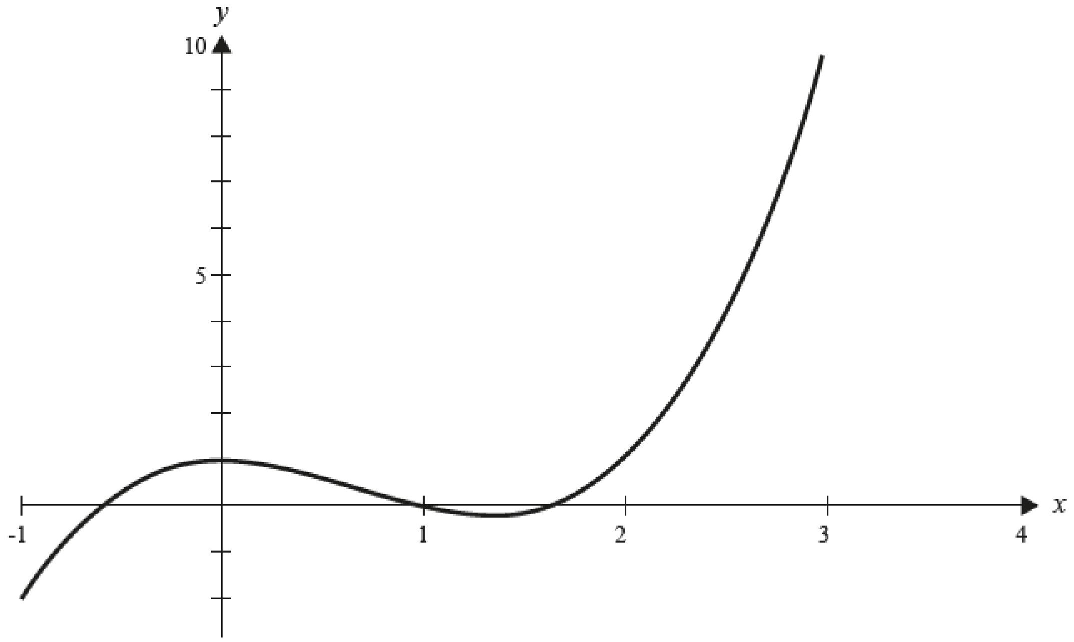
.... **[3]**

This part was not attempted particularly successfully. Quite a few realised that the equation needed differentiating, but many did this poorly and after substituting 3 into their differentiated equation, some went on to divide by 3, since they believed they needed to divide by time. Since the order of the formula is greater than 2, acceleration is not constant, so dividing the distance by the time will not achieve the required result.

Question 5 (a) (i)

5 **(a)** The two graphs below show part of the curve $y = f(x)$.

(i) On the graph sketch the curve $y = f(x) + 3$.

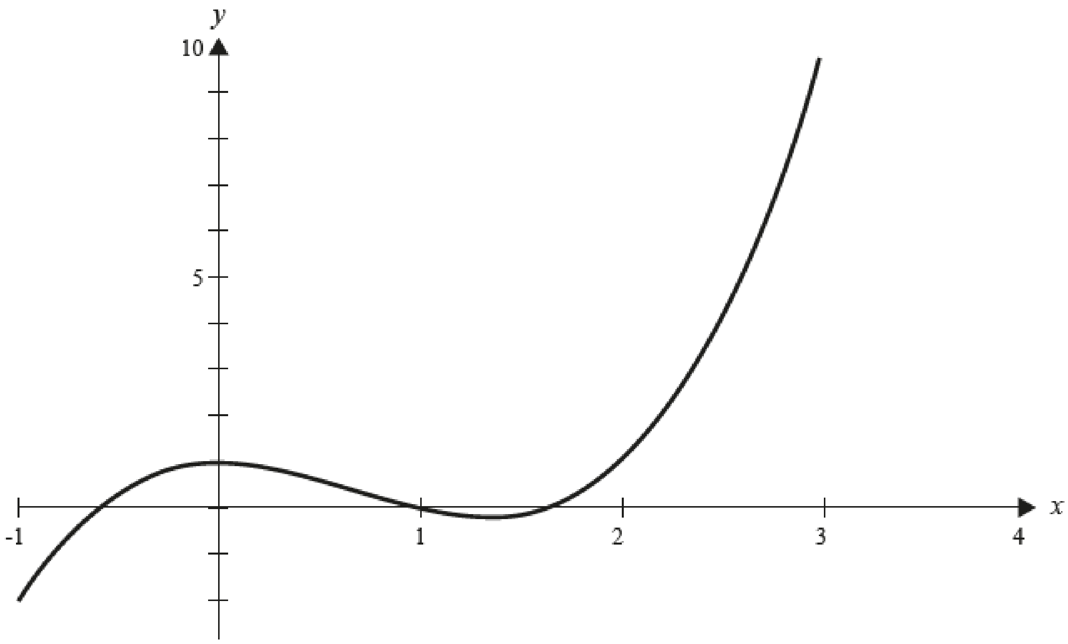


[2]

Plenty of candidates recognised that the curve had been translated but some lacked the accuracy to obtain the correct y intercept value. A few translated parallel to the x-axis.

Question 5 (a) (ii)

(ii) On the graph sketch the curve $y = 3\text{f}(x)$.

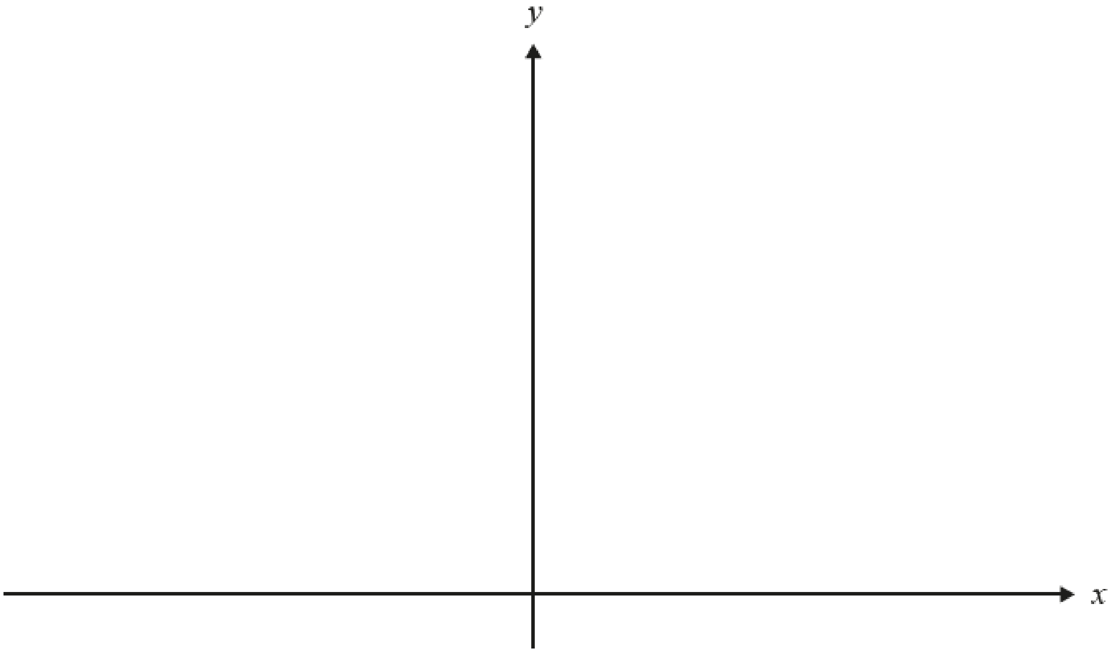


[2]

While recognising that a stretch was needed, most candidates did not acknowledge the fact that the roots on the x-axis would remain the same. Those who did try to consider the y intercept value often passed their curve through (0,4) rather than (0,3).

Question 5 (b)

(b) Sketch the curve $y = 2x^2 - 1$ for $-3 \leqslant x \leqslant 3$ on the axes below.



[2]

The majority of candidates recognised that the graph was U shaped, but many did not achieve a negative intercept.

Question 5 (c)

(c) On the grid below sketch the line $y = 2(x - 1)$.

[2]

Most candidates realised the graph should be linear. Candidates often tried to plot this but with no scaled axis; often this would lead to lines with curves or sharp bends. The examination rubric states that candidates should have available a ruler but this seemed often not to be the case. Candidates seemed also to misunderstand the demand to sketch and often plotted, at some expense of time. A sketch should (usually) show significant points on the graph, such as the intercepts on the axes. Candidates who only provided a line in the positive quadrant therefore only provided part of the required answer.

Question 5 (d) (i)

(d) You are given that $f(x) = x^3 - 7x + 6$.

(i) Find $f(-1)$.

.... **[1]**

The correct solution (12) was achieved by most candidates.

Question 5 (d) (ii)

(ii) Find f(1).

.... **[1]**

The correct solution (0) was achieved by most candidates. Occasionally these two answers were reversed achieving 0 marks for both parts.

Question 5 (d) (iii)

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

....

....

....

....

....

....

....

.... **[4]**

There were a number of ways of finding the roots of the cubic equation. The most obvious was to use the fact that f(1) = 0 from part (a), divide into the cubic and solve the resulting quadratic equation. Finding the other roots by trial was acceptable, but of course this depends on the fact that the other two roots are integers, and the question did not say whether this was the case. Such a method could therefore have taken time to obtain solutions for no purpose.

Question 6 (a)

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

....

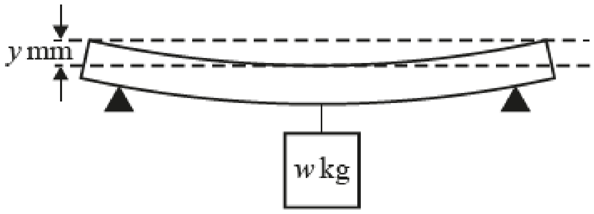
.... **[2]**

Very few candidates were able to fully simplify the logarithmic expression, although many benefitted from marks for partial simplification.

Question 6 (b) (i)

(b) An engineer carried out an experiment to discover how a beam of uniform density and uniform cross section sagged when loaded with a mass in the centre.

He proposed the equation $y = \frac{1}{10} \times 2^w$ where w is the load in kilograms and y is the sag in millimetres.



(i) Calculate the sag when $w = 5$.

....

.... **[1]**

As this question only required substitution of values into the given equation, candidates were mostly able to obtain the required answer.

Question 6 (b) (ii)

(ii) On one trial the sag is 4 mm. Calculate the load w.

....

....

.... **[3]**

Candidates were much less successful at establishing the required value for w in this part of the question. Very few candidates attempted to solve the equation by taking logs, with many opting for trial and improvement methods. This had a mixture of success in finding a value for w to the required level of accuracy. Often the correct value would be seen with little or no working, probably through the use of equation functions on scientific calculators.

Question 7 (a) (i)

7 **(a)** Fifteen employees at a factory make components. They are timed one day to see how long they took in completed hours to make a component. Their times are summarised in the table below.

Hours	5	6	7	8	9	10	15
Frequency	2	3	5	4	0	0	1

(i) Find the mean of the data.

....

....

....

.... **[2]**

The majority of candidates attempted a calculation for the mean with most able to obtain the required value of 7.3 or better. A small number did not recognise that the calculation involved a frequency row.

Question 7 (a) (ii)

(ii) Write down the median of the data.

.... **[1]**

Most candidates were able to identify the median as 7.

Question 7 (a) (iii)

(iii) Write down the mode of the data.

.... **[1]**

(iii) Most candidates were able to identify the mode as 7.

Question 7 (a) (iv)

(iv) The time for the employee who took 15 hours is removed from the data. Without doing any further calculations say what will happen to the mean, median and mode.

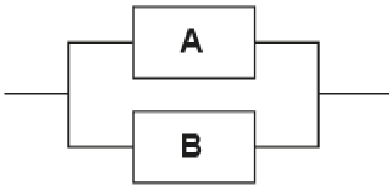
....

.... **[2]**

The removal of a datum item from a set will change the mean, in this case downward. However, the values of the mode and median may not change depending on the item being deleted. In this case neither would change.

Question 7 (b) (i)

(b) (i) In a particular machine there are two components, A and B. They are set up in parallel so that the machine fails only if both components fail.



The probability that a component fails during the period of a day is 0.2, independent of the other one.

Find the probability that the machine fails in the course of a day.

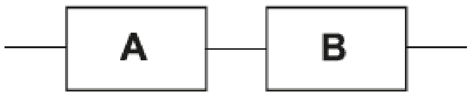
....

.... **[2]**

The first part of the probability question was generally well attempted.

Question 7 (b) (ii)

(ii) In another machine the two components are set up in series. This means that the machine will fail if either of them fails.



If the probability that each component fails during the course of the day is 0.2 as before, find the probability that the machine fails in the course of the day.

....

....

....

.... **[2]**

This part was poorly answered with many candidates just writing 0.2 + 0.2 = 0.4. Some candidates correctly decided that the machine either failed or it did not and that the probability that neither component failed should be multiplied together and the result subtracted from 1. Other methods were less successful, although a proportion did find the correct answer.

Copyright information

Supporting you

For further details of this qualification please visit the subject webpage.

Review of results

If any of your students' results are not as expected, you may wish to consider one of our review of results services. For full information about the options available visit the OCR website. If university places are at stake you may wish to consider priority service 2 reviews of marking which have an earlier deadline to ensure your reviews are processed in time for university applications.

Mark grade boundaries

Find the grade boundaries for this series on the OCR website.

CPD Training

Attend one of our popular CPD courses to hear exam feedback directly from a senior assessor or drop in to an online Q&A session.

Please find details for all our courses on the relevant subject page on our website.

www.ocr.org.uk

The small print

OCR Resources: *the small print*

Looking for a resource?

www.ocr.org.uk

OCR Customer Support Centre

Vocational qualifications

Telephone 02476 851509
Facsimile 02476 851633
Email vocational.qualifications@ocr.org.uk