CAMBRIDGE TECHNICALS

OCR
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CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

ENGINEERING

05822–05825, 05873

Unit 1 Summer 2024 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. A selection of candidate answers is also provided. 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

Many candidates did well, roughly in line with previous cohorts. Nearly all candidates lost a mark or two as a result of arithmetic or algebraic errors.

Many candidates are unable to perform well in some topic areas, in particular, Calculus, Logarithms and Exponentials.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• laid out their work well so that it would be easy for them to check the work done • read the questions carefully in order to understand what was required • demonstrated a confidence in all topics.	• were not fully conversant with all topics and so limited the questions that could be answered • seemed to be confused over processes, e.g. the order of priority of arithmetic operations, whether to differentiate or integrate • demonstrated a weakness in algebraic manipulation • did not appear to use the formula booklet provided.

Question 1 (a)

1

(a) Solve the equation $2x - 3 = 5$.

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

This was found to be an easy start to the paper for most candidates. The most frequent error was to subtract rather than add.

Question 1 (b)

(b) Factorise $2x^2 + 4x$.

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

Most candidates were successful on this question as well. The most common error was to extract only one factor from the expression rather than two.

Question 1 (c)

(c) Write $\frac{x+1}{3} + \frac{x-1}{2}$ as a single fraction.

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

Many candidates were able to find and use the least common multiple. Arithmetic errors were often seen, however.

Question 1 (d)

(d) You are given that $(x-3)^2 = x^2 + ax + b$ where a and b are integers, for all values of x.

Find the values of a and b.

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

A large number of candidates did not realise that they were expected to multiply out the left hand side and then equate coefficients to find *a* and *b*. Some candidates thought that this was all they had to do and so did not write down their values for *a* and *b*.

Exemplar 1

$(x-3)(x-3)$ x^2-6x+9

$x^2-3x-3x+9$

Exemplar 1 demonstrates the lack of care in reading the question. The algebraic work has been done well and the first 2 marks were gained. However, the question asked for values of *a* and *b* and these could have been given but were not, so losing the last mark.

Question 1 (e)

(e) Solve the equation $x^2 + 4x - 7 = 0$.

Give your answers correct to **3** significant figures.

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

Some candidates were unable to solve this quadratic equation, though the formula is given in the Formula Booklet. Some attempted to apply the completion of the square process, usually unsuccessfully, while others only found one root. Errors included not writing the formula as a single fraction and problems with signs. Some obtained the correct roots but did not write them, as required, to 3 significant figures.

Use of calculators

Centres should note that it is acceptable for candidates to use a calculator that can solve these equations. It was assumed that a response giving the two roots with no working came from a calculator - this was acceptable and to be encouraged.

Question 2 (a)

2

(a) You are given that $f(x) = x^3 - 13x + 12$.

You are also given that $f(1) = 0$.

Write $f(x)$ in fully factorised form.

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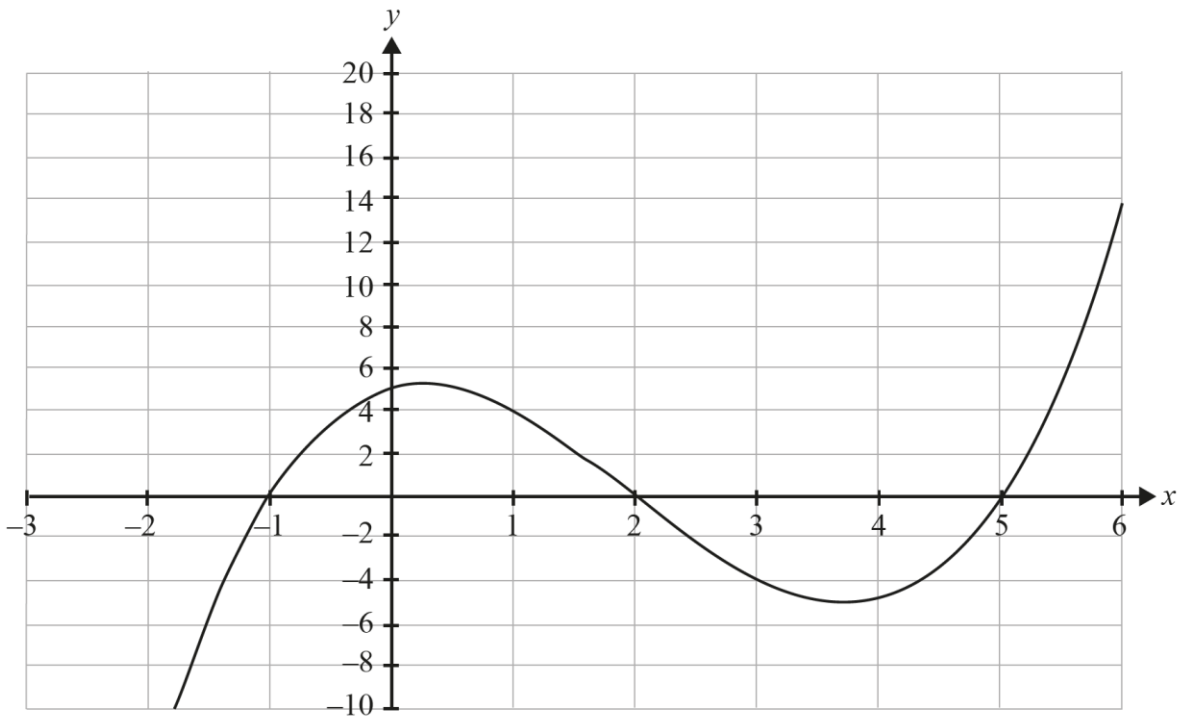
..... **[4]**

Some candidates did not understand the significance of the information given in the question. Most, however, used it to find a quadratic factor which was then factorised to give the final answer.

Some went beyond that asked by the question to solve f(x) = 0

Question 2 (b)

(b) The grid shows part of the graph of $y = g(x)$.



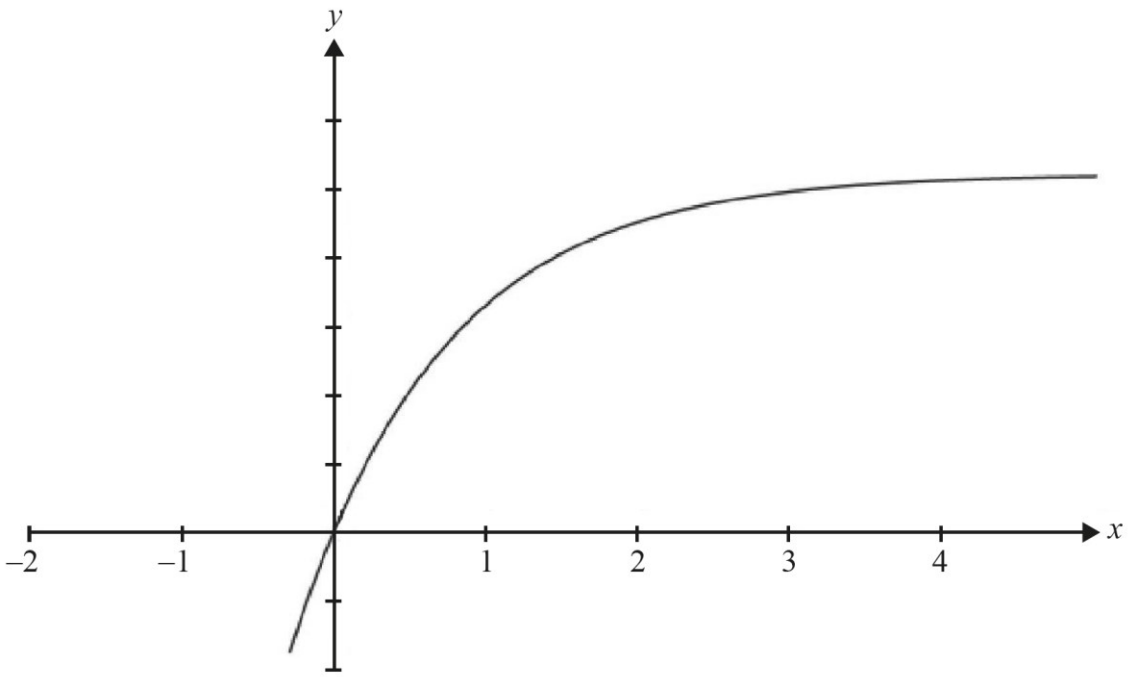
On the same grid sketch the graph $y = 2g(x)$.

[2]

Although 'sketch' does not demand the accuracy of a plot, some of the graphs seen were too badly drawn to be given credit. The significant features should be clear. In this question they are the intercepts on the x-axis and the height relative to the original. Since 2 × 0 = 0 the required curve must go through the same points on the axis as the original. Although it is probable that many candidates knew this, their curve did not actually do so.

Question 2 (c)

(c) The grid shows part of the graph of $y = h(x)$.



On the same grid sketch the graph of $y = h(x - 1)$.

[2]

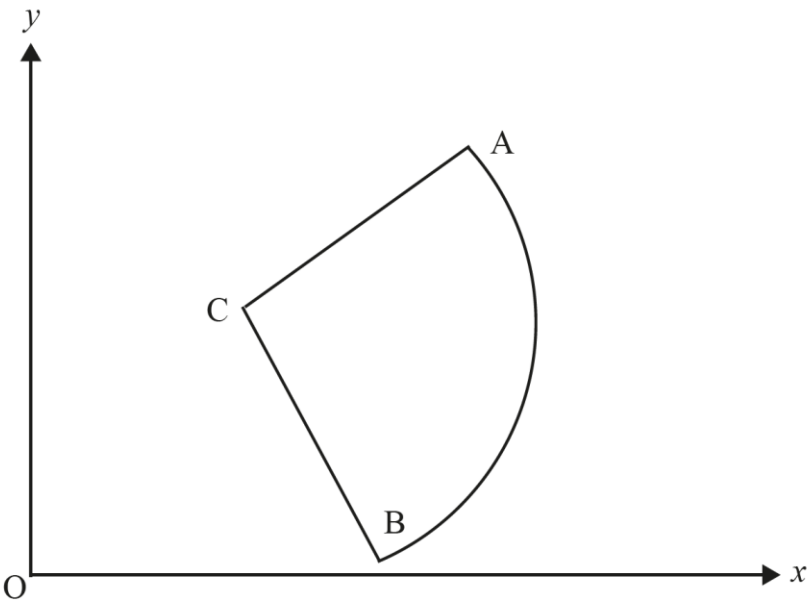
The given curve passes through (0,0). Therefore, the new curve passes through (1,0). Many candidates drew their curve through (-1,0). The drawn curve should converge towards the given curve. Again some candidates probably knew this but the end of their curve dipped down due to poor drawing and so for increasing *x*, the curves diverged.

Question 3 (a) (i)

3

(a) A part of a machine is the sector of a circle.

Drawn on a coordinate system, the equation of the circle is $x^2 + y^2 - 12x - 14y + 60 = 0$.



(i) Find the coordinates of the centre, C, and the radius of the circle.

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

Many candidates were not able to manipulate the equation algebraically to obtain the form required to give them the centre and radius. This hindered them in later parts of the question.

Question 3 (a) (ii)

The sector of the circle is bounded by the lines CA, CB and the arc AB.
The coordinates of A and B are (10,10) and (9,3) respectively.

(ii) Verify that A and B lie on the circle.

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

A point that lies on the circumference of the circle will have coordinates that satisfy the equation. Substitution of the given points was therefore all that was required here and most did so successfully. A few found the distances CA and CB to show that they were equal to the radius.

Exemplar 2

$(10-6)^2+(10-7)^2-25=0$ ∴ A lies on the circle

$(9-6)^2+(3-7)^2-25=0$ ∴ B lies on the circle

Exemplar 2 shows all that was required to verify the result. Candidates might note that there was only 1 mark available meaning that a lengthy response is not required.

Question 3 (a) (iii)

(iii) Find the distance from A to B along the straight line AB.

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

This question did not depend on knowledge of the centre or the radius so errors in earlier parts should have been irrelevant. A straightforward use of Pythagoras was all that was required.

Question 3 (a) (iv)

(iv) Determine the angle ACB.

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

There were two possible ways to find the angle at C. The first was to note that the sides CA, CB and AB satisfied Pythagoras' Theorem, meaning that the triangle was right-angled.

The second was to use the cosine rule, given the three sides. In many cases this proved difficult as the manipulation of the formula created errors. Additionally, having approximated the length AB (usually to 3 significant figures), the approximation was then used. This created an error as the exact length of AB was not being used. The consequence was that the angle found was not exactly 90^0, but the approximation was accepted.

A much longer process was to use the cosine rule to find that the angle CAB was 45^0, to assert (correctly) that CBA was therefore also 45^0 and the angle at C = 90^0. However, this required justification that the two angles were equal.

Question 3 (a) (v)

(v) Find the distance from A to B along the arc of the circle.

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

Candidates commonly used the formula given in the Formula Booklet obtain the correct answer. If the use of an incorrect value for the angle at C and/or the radius found in 3(a)(i) was followed through, it was given full credit as long as there was no further error.

Question 3 (b)

(b) A prop shaft is rotating at 2 radians per second.

Express this in revolutions per minute.

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

Many candidates thought that it was necessary to convert 2 radians to degrees. While many of these candidates were given full credit for the correct answer, an extra step resulting in errors in the arithmetic were made. The easiest way, not involving degrees, was to use the knowledge that one revolution is 2π radians and that therefore 2 radians is $1/\pi$ revolutions multiplied by 60. Many candidates were able to do this well.

Question 4 (a)

4

(a) Four students are asked to select a sample of 20 students from their year group to undertake a survey.

The year group consists of 100 students, split into 5 equal classes of 20.

- Alex selects as his sample the whole of one class to represent the year group.
- Beth selects as her sample the first 20 students in the year group who enter the school one morning.
- Charlie chooses the first 20 students from the alphabetical list of students.
- Dev assigns a number to each student, writes the numbers onto pieces of paper and puts them all into a hat. He then pulls out 20 pieces of paper and the 20 numbers are the students in his sample.

Which **one** of the students has chosen a random sample?

Tick (✓) **one** box only.

Alex	
Beth	
Charlie	
Dev	

[1]

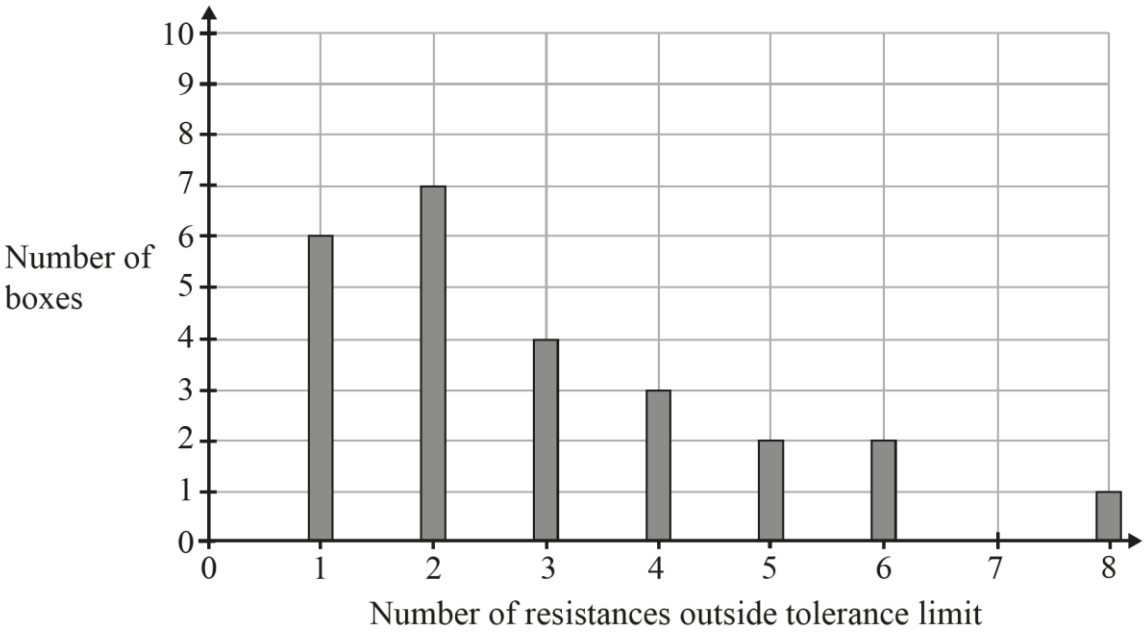
Any of the first three methods may well be a convenient way to select the sample, but the only random choice was made by Dev and the vast majority of candidates selected this one.

Question 4 (b) (i)

(b) Resistors made by a company are distributed in boxes of 50 resistors.

A number of boxes were checked and the vertical line chart below summarises the number of resistors in each box that had a resistance outside the tolerance limit.

Every box checked had at least 1 resistor that was outside the tolerance limits.



(i) How many boxes were checked?

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

Candidates answered this part well, sometimes without the need for any working.

Question 4 (b) (ii)

(ii) Find the median number of resistors per box that were outside the tolerance limit.

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

Some candidates did not understand what a median is. Those that wrote down the number of resistors outside the tolerance limit in numerical order, picking out the middle one, usually obtained the correct answer.

Question 4 (b) (iii)

(iii) One box is chosen at random from this set of boxes.

Find the probability that the number of resistors outside the tolerance limit exceeds 3.

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

The candidates who performed well in previous parts usually had no trouble with this probability question. Misunderstandings about the given diagram, however, created difficulties here as well. A few candidates found the probability that the number was 3 or less and then subtracted from 1.

Question 5 (a)

5 When a capacitor, C, is discharged through a resistor, R, the voltage, V, at time t, is given by the formula $V = 12e^{\frac{-t}{RC}}$ where $RC = 1.2$.

(a) Write down the initial voltage.

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

Many candidates were not secure in their understanding of this topic. So, in a number of cases some calculation was done to find an answer, even though the 'write down' instructions meant that no work was necessary.

Question 5 (b)

The resistance of the resistor is 600 Ω.

(b) Find the value of the capacitor, stating your units.

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

In this part, also, a lot of invalid work was done with exponentials instead of taking the given formula $RC = 1.2$ with the given value for R to find C.

Question 5 (c)

(c) Find the voltage after 3 seconds.

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

Most candidates completed the substitution correctly but either used wrong values or did not calculate correctly.

Question 5 (d)

(d) Calculate after how many seconds the voltage is 1.2 V.

Give your answer to **3** significant figures.

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

The substitution in this part, usually well done, resulted in an equation in which *t* was not the subject. The process of using logarithms to find the value of *t* was usually poor: along with exponentials, logarithms is a topic that is not well understood.

A few candidates who were able to complete the question lost a mark for not giving their answer correct to 3 significant figures. Even though this is a different skill, it is important that candidates can give approximations to answers by round to a given number of significant figures or decimal places.

Question 6 (a)

6 The curve $y = \frac{x^3}{8} - \frac{3x^2}{4} + 5$ has two stationary points.

(a) Use calculus to show that the coordinates of the turning points are (0, 5) and (4, 1).

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

The differentiation of this equation was usually well done. From this there were two methods to show that the values for *x* were x = 0 and x = 4.

One way was to substitute the two values into the gradient function and show that the result was zero. While there was no working for *x* = 0, the calculation for *x* = 4 had to be seen.

The second method was to set the gradient function equal to zero and solve the resulting quadratic equation.

A large number of candidates, however, did not show enough working to justify gaining the marks and many just wrote down *x* = 0 and *x* = 4 with no working at all. As these values had been given in the question, working had to be seen.

Likewise, the associated values of *y* had to be seen to have been calculated rather than just written down.

'Show that…' questions

If the question says 'show that…' it is important that all working is shown to demonstrate that the candidate has understood what is required and worked through all steps to the desired end result.

Exemplar 3

$y = \frac{1}{8}x^3 - \frac{3}{4}x^2 + 5$

$\frac{dy}{dx} = \frac{3}{8}x^2 - \frac{3}{2}x$

when $x = 0$ $\frac{dy}{dx} = 0$ ✓ so it is a turning point

$y = \frac{0^3}{8} - \frac{3 \times 0^2}{4} + 5$ so $y = 5$ so turning pt. $= (0, 5)$

when $x = 4$ $\frac{dy}{dx} = 0$ ✓ so it is a turning point

[4]

$y = \frac{4^3}{8} - \frac{3 \times 4^2}{4} + 5 = 1$ so turning pt. $= (4, 1)$

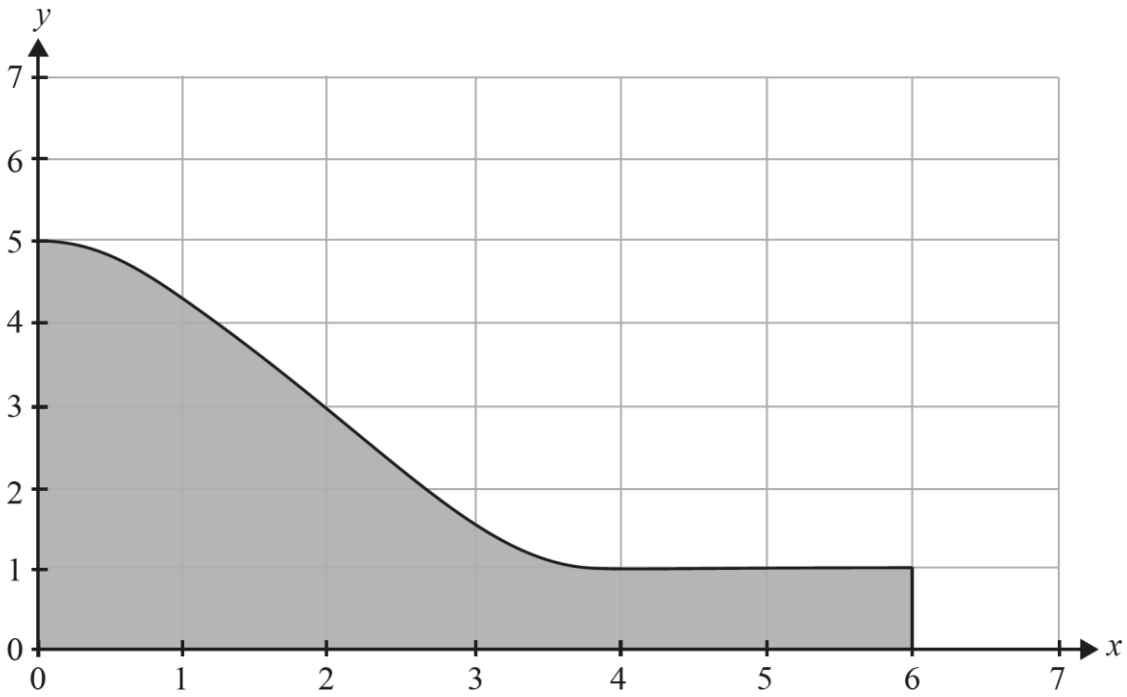
In Exemplar 3, most of the work was completed successfully. However, there was no justification for the assertion that the gradient function was 0 when x = 4. Given that this value is given it is important that full working must be shown to demonstrate that the value has not just been written down. Candidates in this case could only score half marks.

Question 6 (b)

(b) The graph shows the curve $y = \frac{x^3}{8} - \frac{3x^2}{4} + 5$ for $0 \leqslant x \leqslant 4$ and the line $y = 1$ for $4 \leqslant x \leqslant 6$.

It represents the side of a playground slide.

Units are metres.



Find the area enclosed by the axes, the line $x = 6$ and the curve.

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

Although there was no demand to use calculus, integration was the only way to find the answer that was within the syllabus. Many completed the question well. Others, however, did not read the question carefully enough and took limits [0. 6] rather than [0,4].

A significant number used approximation methods which was allowed even though they are not in the specification.

Some used the Trapezium Rule and others the midpoint rule. Because of the rotational symmetry of the curve both of these methods gave the correct answer for h = 1, 2 and 4. Constructing rectangles entirely below the curve will only find an approximation to the area and so was not accepted.

Many had no clear plan but split the area into shapes of various sizes which were usually incorrect.

The additional of the extra rectangle was required which some candidates forgot.

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