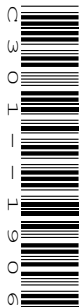# OCR
Oxford Cambridge and RSA

Monday 13 May 2019 – Afternoon

LEVEL 3 CAMBRIDGE TECHNICAL IN ENGINEERING

05822/05823/05824/05825/05873   Unit 1: Mathematics for engineering

Time allowed: 1 hour 30 minutes
C301/1906

You must have:
• the formula booklet for Level 3 Cambridge Technical in Engineering (inserted)
• a ruler (cm/mm)
• a scientific calculator

Please write clearly in black ink.

Centre number						Candidate number				

First name(s) _____

Last name _____

Date of Birth | D | D | M | M | Y | Y | Y | Y |

INSTRUCTIONS
• Use black ink. You may use an HB pencil for graphs and diagrams.
• Answer **all** the questions.
• Write your answer to each question in the space provided. Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).

INFORMATION
• The total mark for this paper is **60**.
• The marks for each question are shown in brackets **[ ]**.
• Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
• An answer may receive no marks unless you show sufficient detail of the working to indicate that a correct method is being used.
• Final answers should be given to a degree of accuracy appropriate to the context.
• This document consists of **12** pages.

FOR EXAMINER USE ONLY	
Question No	Mark
1	/6
2	/8
3	/8
4	/8
5	/14
6	/6
7	/10
Total	**/60**

OCR is an exempt Charity   **Turn over**

Answer **all** the questions.

1 **(a)** Multiply out the brackets and simplify

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

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.... **[2]**

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

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.... **[2]**

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

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.... **[2]**

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.

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.... **[3]**

(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 $\theta\,°C$ 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.

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.... **[2]**

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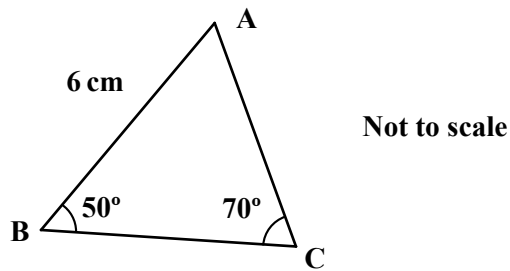
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.... **[3]**

Turn over

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

.... **[1]**

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

.... **[1]**

(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.

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.... **[3]**

(ii) Find the area of the triangle ABC.

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.... **[3]**

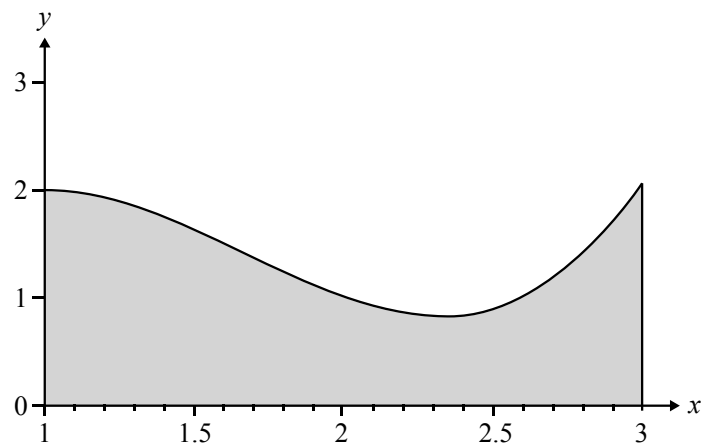**4 (a)** A trough has cross-sectional shape given by the equation

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

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 $x = 3$.

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.... **[4]**

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

Find the volume of the trough.

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.... **[1]**

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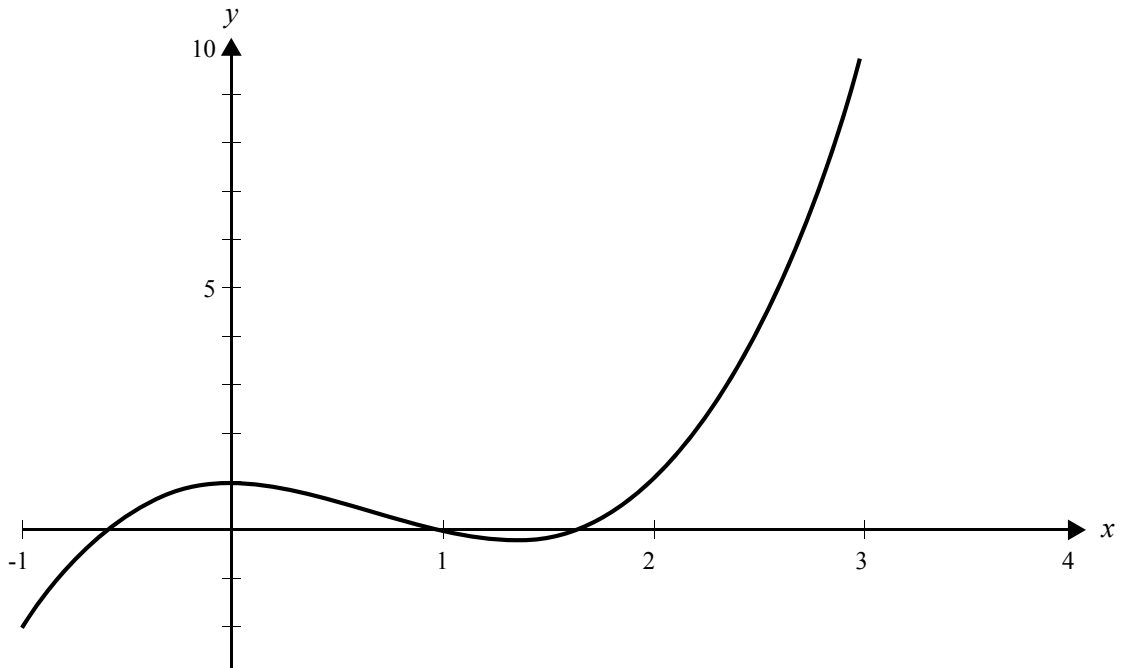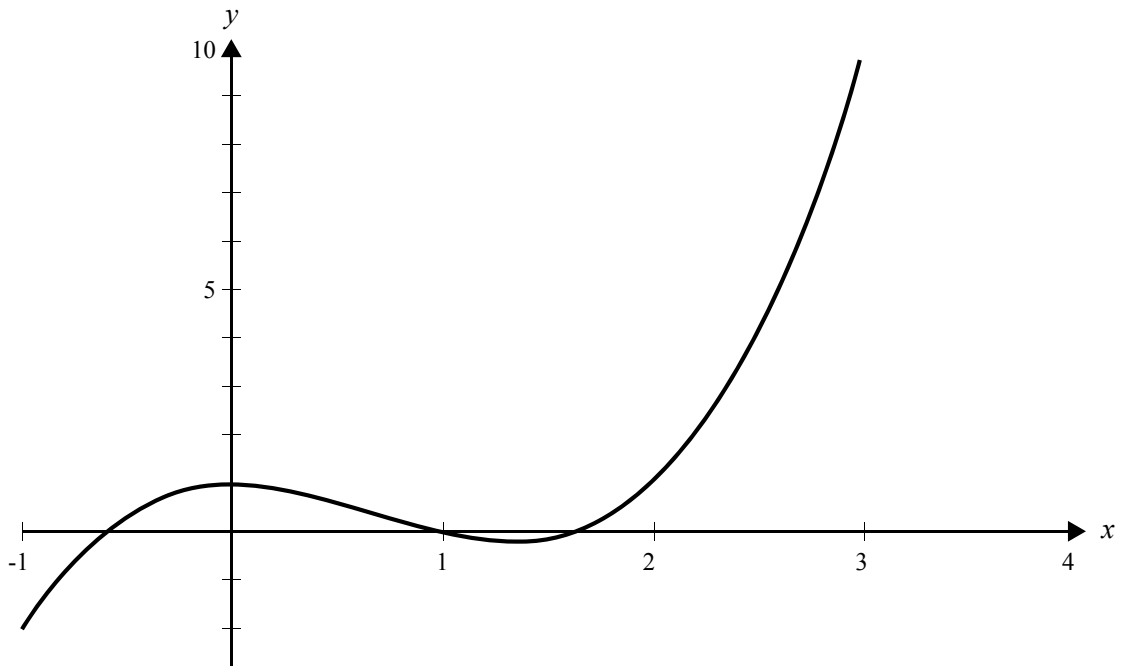Using differentiation, find the velocity after 3 seconds.

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.... **[3]**

5 (a) The two graphs below show part of the curve $y = f(x)$.
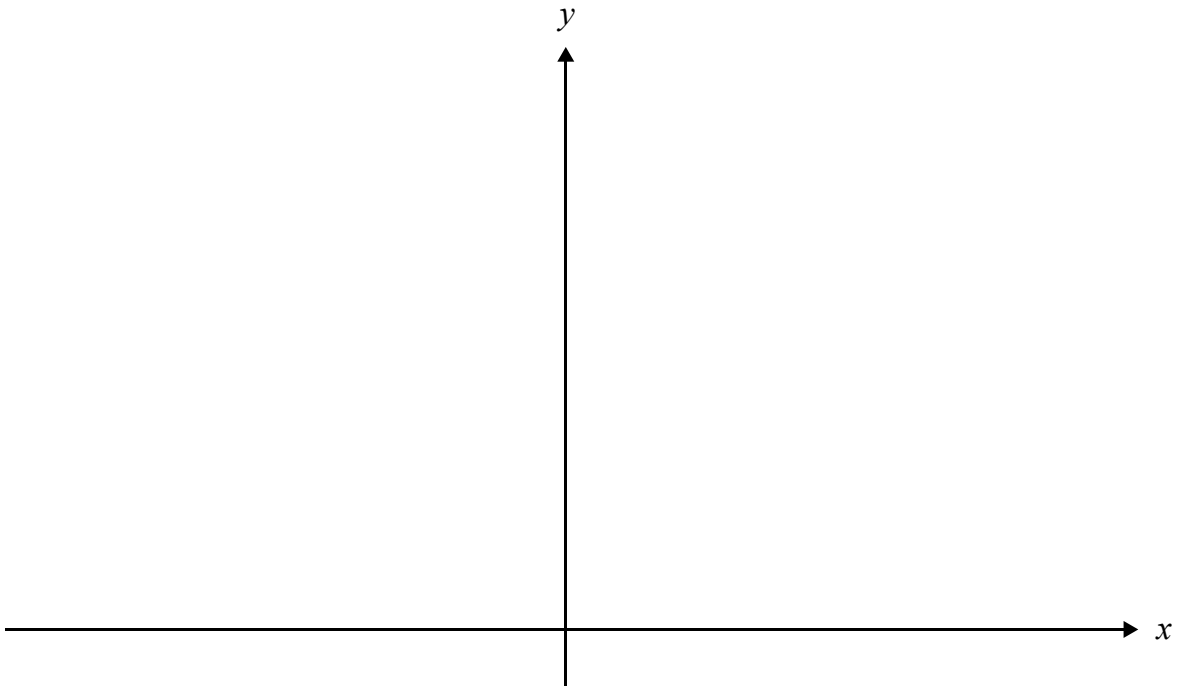
(i) On the graph sketch the curve $y = f(x) + 3$.

[2]

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

[2]

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

y

x

[2]

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

y

x

[2]

Turn over

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

   (i) Find f(−1).

      .... **[1]**

  (ii) Find f(1).

      .... **[1]**

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

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      .... **[4]**

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

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.... **[2]**

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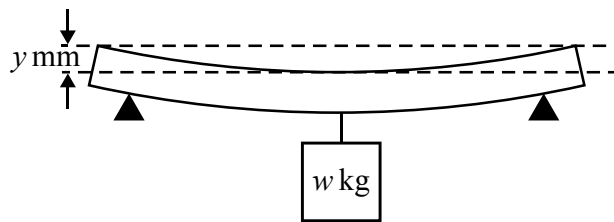
(i) Calculate the sag when $w = 5$.

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.... **[1]**

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

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.... **[3]**

Turn over

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.

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.... **[2]**

(ii) Write down the median of the data.

.... **[1]**

(iii) Write down the mode of the data.

.... **[1]**

(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.

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.... **[2]**

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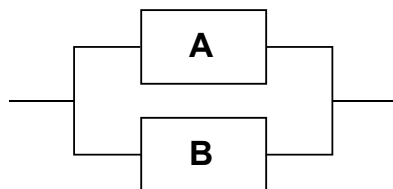
The probability that a component fails during the period of a day is 0.2, independent of the other one.

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

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.... **[2]**

(ii) In another machine the two components are set up in series. This means that the machine will fail if either of them fails.
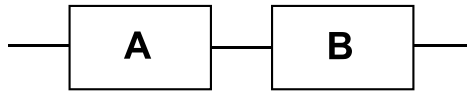
If the probability that each component fails during the course of the day is 0.2 as before, find the probability that the machine fails in the course of the day.

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.... **[2]**

END OF QUESTION PAPER

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