OCR
Oxford Cambridge and RSA

Level 3 Cambridge Technical in Engineering
05822/05823/05824/05825

Unit 1: Mathematics for engineering

Monday 16 May 2016 – Morning
Time allowed: 1 hour 30 minutes

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

First Name		Last Name	
Centre Number		Candidate Number	
Date of Birth			

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number, candidate number and date of birth.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

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 **16** pages. Any blank pages are indicated.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/10
2	/11
3	/8
4	/10
5	/13
6	/8
Total	**/60**

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Question 1 begins on page 3

Answer **all** questions.

1 **(a)** Remove the brackets and simplify $2(x+3)+(2x-5)$.

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

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

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

(c) Express as a single fraction $\frac{x-2}{3}+\frac{2x+1}{4}$.

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

(d) Transpose $s=ut+\frac{1}{2}at^2$ to make a the subject.

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

2 **(a)** Solve the equation $2(x-1)+3(4-x)=5$.

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

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

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

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

(ii) Using f(2) = 0, solve the equation f(x) = 0 given that there are three integer roots.

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

(c) Fig. 1 shows a wooden shape ABCD, constructed in the form of a kite.
The coordinates are A (0, 16), C (12, 0) and D (2, 5).

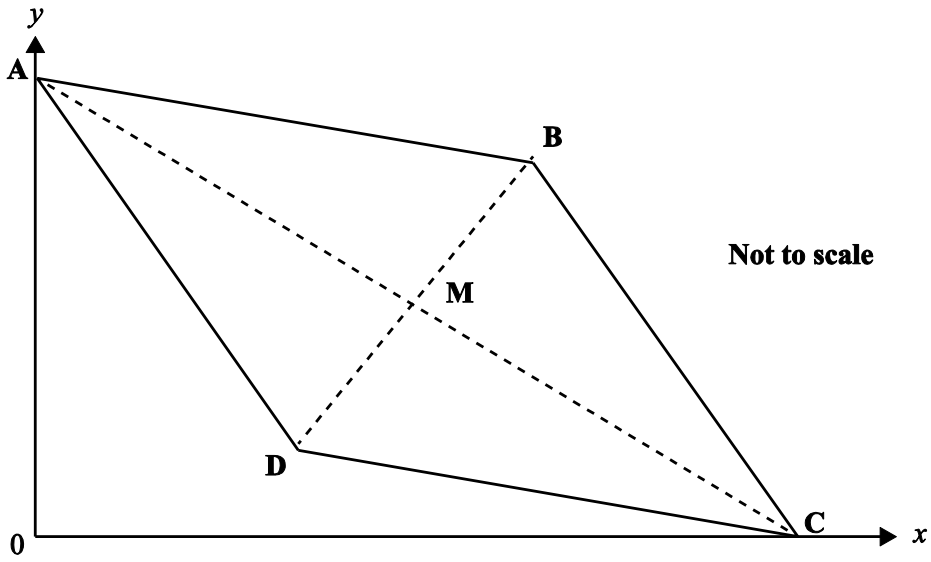

Fig. 1

(i) Calculate the coordinates of the mid-point, M, of AC.

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

(ii) Show by calculation that the line DM is perpendicular to AC.

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

(iii) Calculate the coordinates of point B.

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

3 A cup of water is brought to the boil. When the temperature is 100 ºC the heat is removed and the cup is allowed to cool.

The formula for the temperature of the water, T ºC, at time t minutes after the heat is removed is:

$$T = T_R + (T_0 - T_R)e^{-kt}$$

where T_R is the room temperature, T_0 is the initial temperature and k is the cooling constant.

You are given that $T_0 = 100$ and $T_R = 20$.

(i) Using the values given above for T_0 and T_R, write the formula for T in its simplest form.

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

(ii) Calculate k, given that $T = 70$ when $t = 6$.

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

(iii) Calculate the time taken, to the nearest minute, for the temperature of the water to drop to 50 °C.

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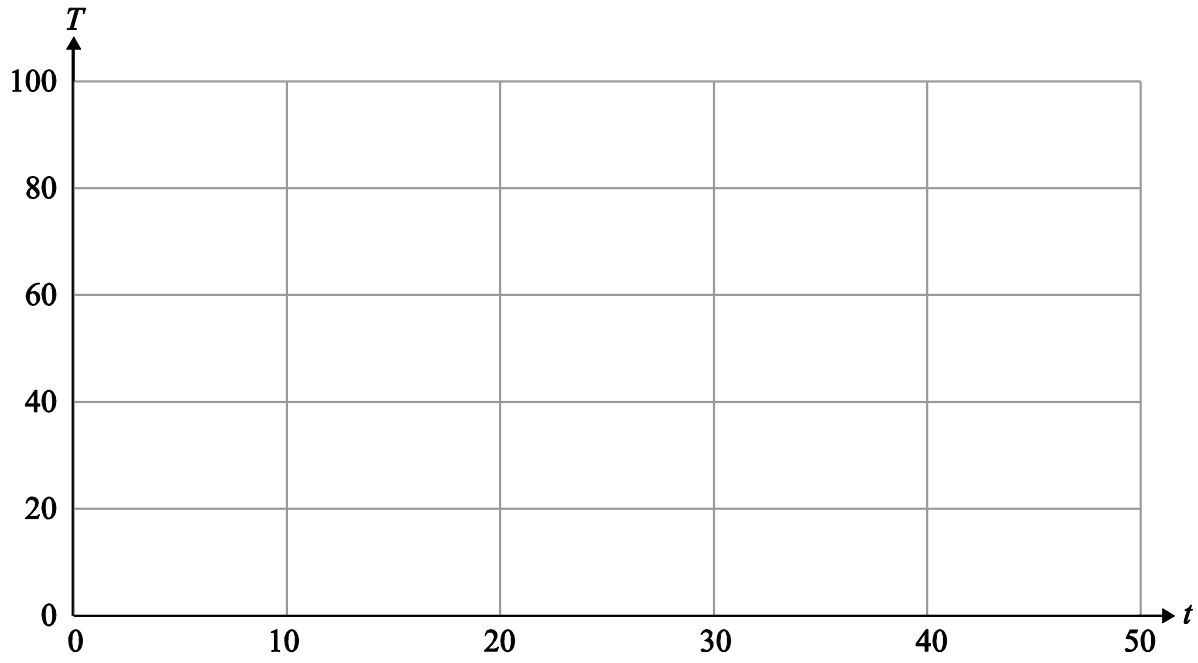
..... **[2]**

(iv) On the grid, sketch the graph of T against t.



[2]

4 **(a)** A triangular plate, ABC, has dimensions AB = 120 mm, AC = 110 mm and BC = 100 mm.

Calculate angle *C*.

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

(b) An alternating e.m.f. is represented by $v = 40\sin x$.

(i) Calculate v when $x = 30^\circ$.

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

(ii) Calculate the **two** values of x in the range $0^\circ < x < 360^\circ$ when $v = 10$.

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

(c) A machine used by surveyors is a wheel of diameter 300 mm which is used to measure the length of a line.

The wheel is placed on the ground and rolled along the line. It rotates exactly 25 times.

Calculate the length of the line.

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

5 **(a)** A small open box is to be made out of a rectangular piece of metal 50 mm by 80 mm of negligible thickness, as shown in Fig. 2. From each corner a square of length x mm is cut and the sides turned up to form the open box.

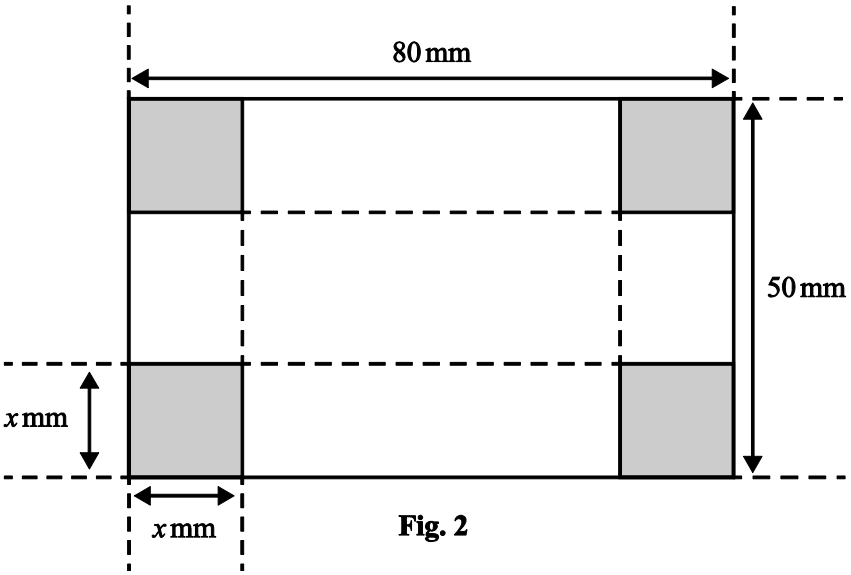

Fig. 2

(i) Show that the formula for the volume, V mm^3, of the box, is given by

$$V = 4x^3 - 260x^2 + 4000x.$$

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

(ii) Using calculus, calculate the value of x that gives the maximum volume.

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

(iii) For this value of x, calculate the volume of the box.

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

(b) The side panel of a children's slide is as shown on a coordinate system in Fig. 3.

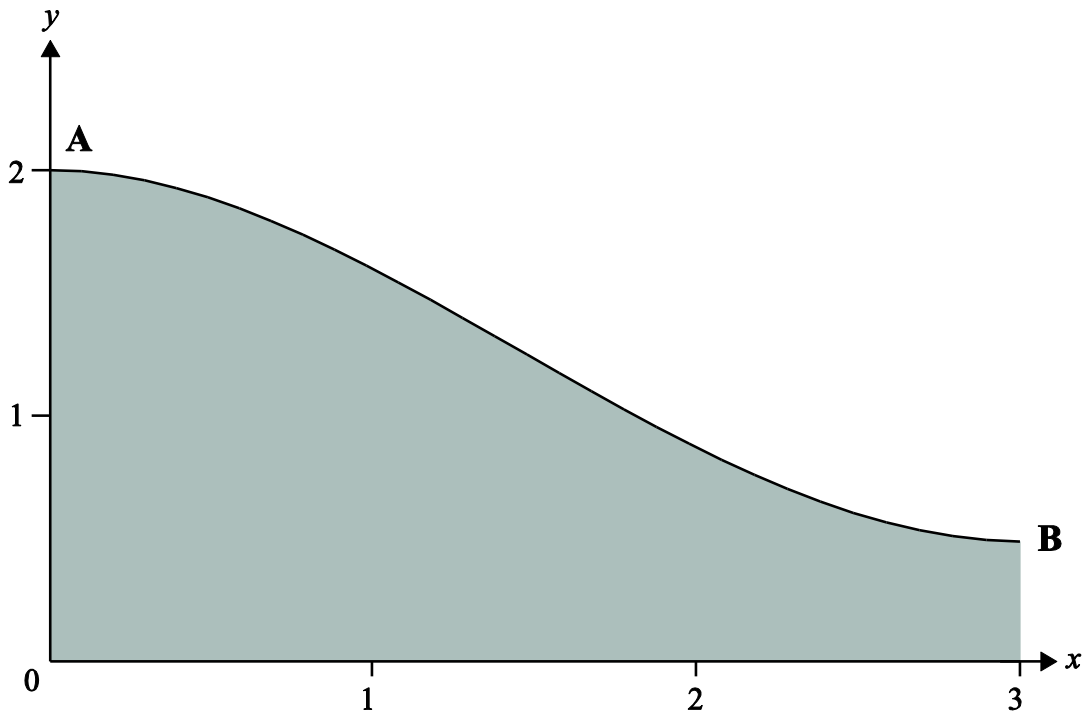

Fig. 3

The coordinates of A are (0, 2) and B are (3, $\frac{1}{2}$). The equation of the top edge, AB, is

$$y = \frac{1}{9}x^3 - \frac{1}{2}x^2 + 2\,.$$

Units are metres.

Using calculus, calculate the area of the side panel.

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

6 **(a)** A machine is set to produce metal bars of length 60 mm. It is known that over a long period the lengths are normally distributed with mean 60 mm and standard deviation 0.39 mm.

One day a check is carried out on the lengths of the bars and the following lengths, correct to the nearest 0.2 mm, are recorded.

Length, x	**Frequency,** f	$x \times f$
59.0	0	
59.2	3	
59.4	5	
59.6	10	
59.8	14	
60.0	16	
60.2	15	
60.4	9	
60.6	5	
60.8	2	
61.0	1	
SUM	$\sum f = 80$	$\sum fx =$

(i) Fill in the cells in the table above and show that the mean of these data is 60 mm.

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

(ii) You are given that the standard deviation of this set of data is 0.39, correct to 2 decimal places.
For a normal distribution it is known that 99% of data lie within 2.58 standard deviations of the mean.

Identify the element in this set of data that might not lie within 2.58 standard deviations of the mean, given that the data above are recorded to the nearest 0.2 mm.

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

(b) A machine has two components, A and B. In order to operate at least one of the components needs to be working. The machine is serviced overnight so that it is set to operate at the beginning of the day with both components working. During the course of the day the probability of A failing is $\frac{1}{4}$ and the probability of B failing is $\frac{1}{5}$.

Find the probability that the machine is still operating at the end of the day.

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).