OCR
Oxford Cambridge and RSA

Level 3 Cambridge Technical in Engineering
05822/05823/05824/05825/05873

Unit 1: Mathematics for engineering

Monday 15 May 2017 – Afternoon
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	D	D	M	M	Y	Y	Y	Y			

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 **12** pages.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/13
2	/13
3	/7
4	/9
5	/8
6	/10
Total	**/60**

Answer **all** the questions.

1 **(a)** Solve the equation $2(x+2)-5=9$.

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

(b) Write as a single fraction.

$$\frac{2x+1}{3}+\frac{3x-2}{6}$$

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

(c) The period, T seconds, of a pendulum of length L is given by the formula $T=2\pi\sqrt{\frac{L}{g}}$.
Rearrange this formula so that L is the subject.

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

(d) (i) You are given the cubic function $f(x) = x^3 - 13x + 12$.

Show that $f(x)$ can be written as $(x-1)(x^2+x-12)$.

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

(ii) Hence factorise $f(x)$ completely.

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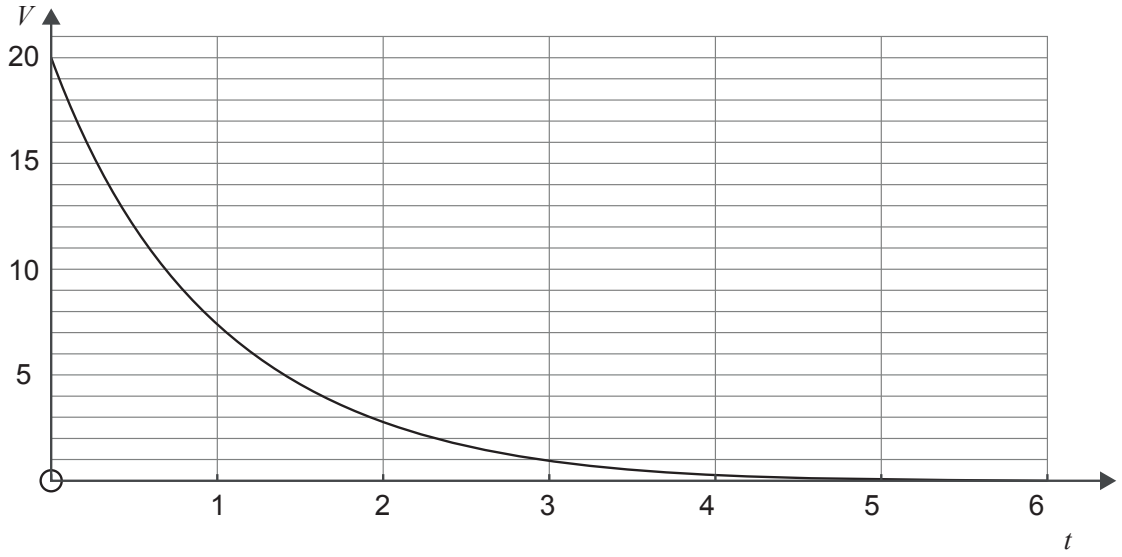
..... **[2]**

2 **(a)** The graph below represents the voltage decay in a capacitor circuit.

The equation of the curve is $V = ke^{at}$ where V is measured in volts and t is the time in seconds.



(i) Identify the value of k and explain what it represents.

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

(ii) The curve passes through the point (3, 1). Find the value of a.

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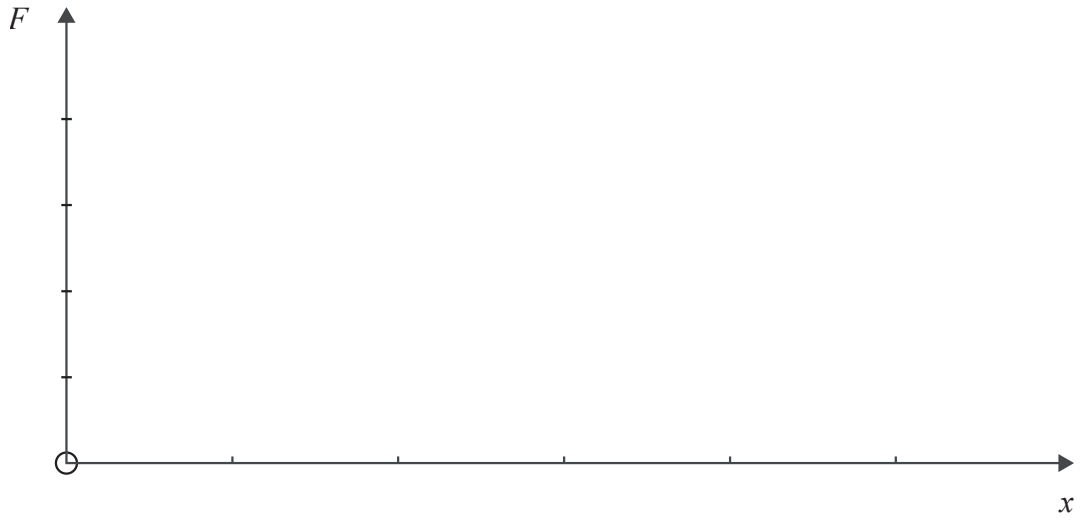
..... **[3]**

(b) The force, F, required to compress a coil spring a distance x from its natural length is given by

$$F = kx$$

where k is a constant.

Sketch a graph of $F = kx$ on the axes below.



[2]

(c) On a coordinate grid the point A has coordinates (2, 5) and the point B has coordinates (6, 9).

Find

(i) the midpoint of AB,

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

(ii) the gradient of the line AB,

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

(iii) the equation of the line AB.

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

3 An exhibition stand is to be carpeted using red and green carpet.

The red carpet is rectangular of size 4 m by 7 m. It is to be surrounded by a green carpet border of constant width, as shown in Fig. 1.

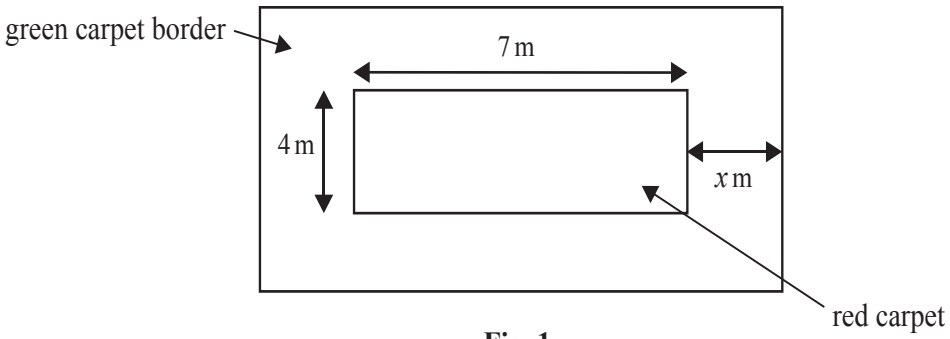

Fig. 1

The width of the green carpet is x m.

(i) Show that the area of green carpet is $4x^2 + 22x$.

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

(ii) The area of green carpet is 42 m^2.

Find the value of x.

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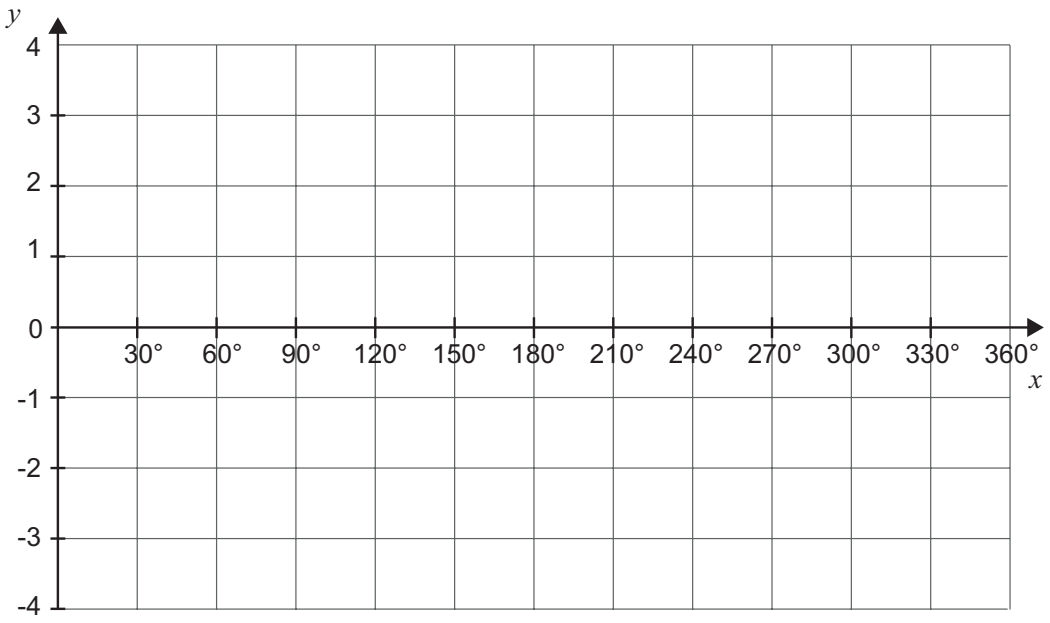
..... **[4]**

4 **(a)** On the grid below, sketch the graphs of

- $y = \sin x$,
- $y = \sin x - 1$,
- $y = 2\sin x$.

Label each graph clearly.



[3]

(b) A window has the shape of a square ABCD with a curved top BC as shown in Fig. 2.

The curved top BC is the arc of a circle with centre M.

M is the midpoint of the base AD. AB = DC = AD = 2 m.

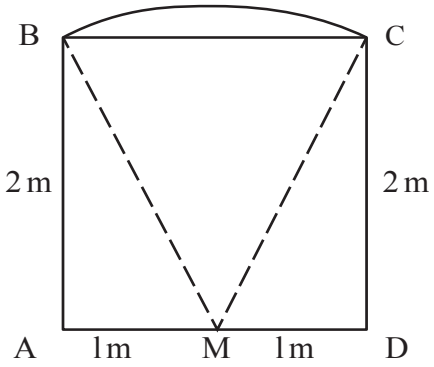


Fig. 2

(i) Find the length MB.

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

(ii) Show that the angle BMC is approximately 53^0.

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

(iii) Hence find the length of the curved side, BC.

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

5 **(a)** A metal plate OADBC has three straight edges OA, OC and CB, and one curved edge ADB.

Fig. 3 shows the shape of the plate overlaid onto a Cartesian coordinate system (x, y), where corner O is located at the origin.

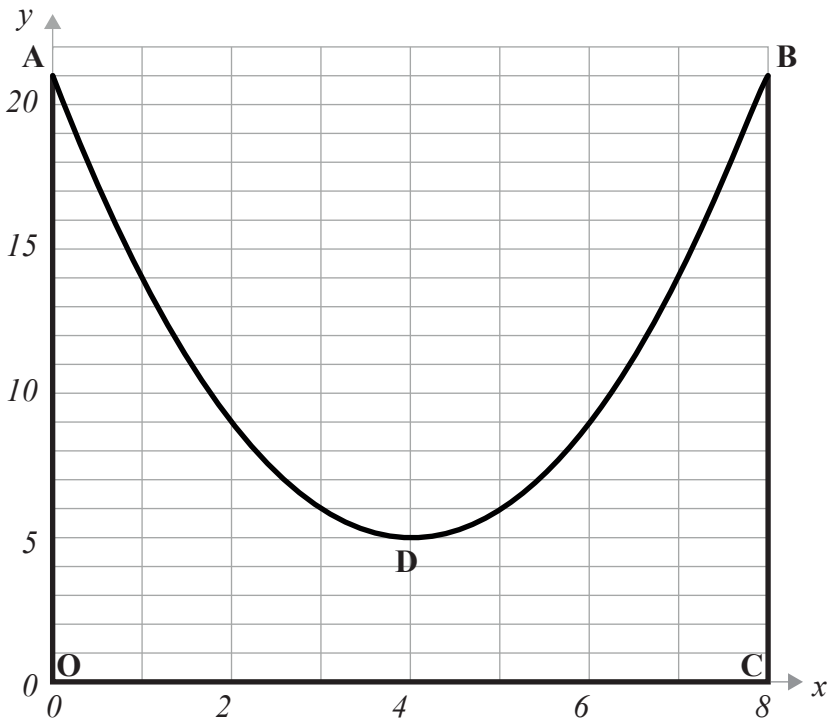

Fig.3

On a coordinate system the points O, A, B and C have coordinates (0,0), (0, 21), (8, 21) and (8, 0) respectively.

The curved side ADB has equation $y = x^2 - 8x + 21$. Units are centimetres.

(i) Use integration to find the area of the metal plate.

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

(ii) The point D is the turning point of the curve.

Using differentiation, show that the coordinates of D are (4, 5).

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

6 **(a)** A bag contains 50 small discs which are painted either red or blue. 40% of the discs are blue.

(i) John takes a disc at random from the bag, notes its colour then returns it to the bag before drawing a second disc at random.

What is the probability that both discs are red?

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

(ii) If instead, John does not return the first disc before drawing the second, what is the probability that they are both red?

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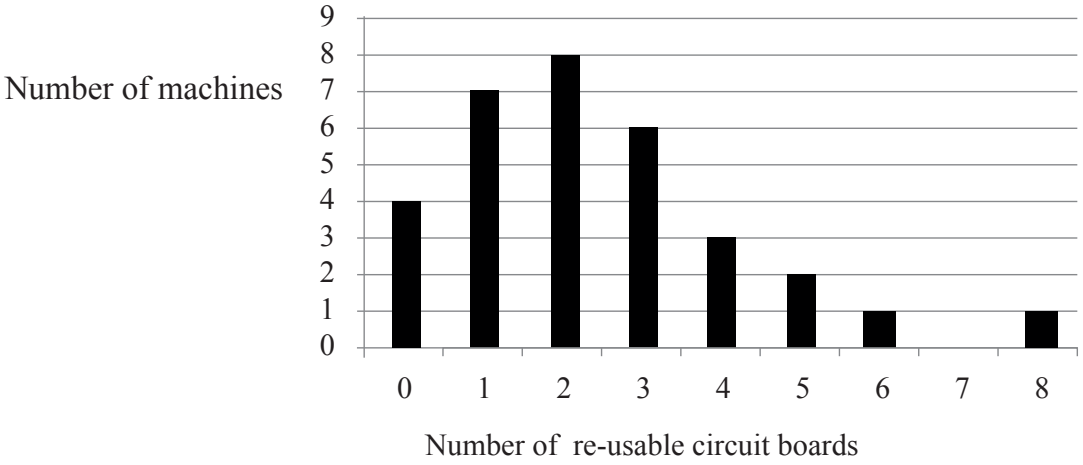
..... **[3]**

(b) 32 electrical machines are to be scrapped. Each machine has a number of circuit boards that could be re-used. An electrical engineer removes the circuit boards from each machine to find out how many re-usable circuit boards there are in each one.

The bar chart below shows the findings.



(i) Find the median number of re-usable circuit boards in a machine.

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

(ii) Find the modal number of re-usable circuit boards in a machine.

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

(iii) Describe the skew of this distribution and explain what this means.

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined pages. The question number(s) must be clearly shown – for example 1(d) or 6(b).