OCR
Oxford Cambridge and RSA

Wednesday 9 January 2019 – Afternoon

LEVEL 3 CAMBRIDGE TECHNICAL IN ENGINEERING

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

Duration: 1 hour 30 minutes

C301/1901

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	/11
3	/7
4	/10
5	/7
6	/4
7	/8
Total	**/60**

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C301/1901/11

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Turn over

Answer **all** the questions.

1 **(a)** Factorise $5x + 10y$.

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.... **[1]**

(b) Remove the brackets and simplify $5(x - 3) + 20 - x$.

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.... **[2]**

(c) Express as a single fraction $\dfrac{5x + 2}{3} - \dfrac{x + 1}{2}$.

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.... **[3]**

(d) Simplify $\dfrac{x^2 + x - 12}{x - 3}$.

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(e) Solve the equation $3(2x - 3) = 1 - 4x$.

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.... **[3]**

(f) Solve the equation $x^2 - 3x + 2 = 0$.

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.... **[2]**

2 (a) The kinetic energy, K joules, of a car with mass m kilograms which is moving at v metres per second is given by the formula $K = \frac{1}{2}mv^2$.

Rewrite this formula so that v is the subject.

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.... **[3]**

(b) A ball is projected vertically upwards at $30\,\text{m s}^{-1}$. The height of the ball, h metres above the ground, after t seconds is given by the formula $h = 30t - 5t^2$.

(i) Find the times when the ball is 30 metres above the ground. Indicate the units used in your answer.

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(ii) By using calculus, find the maximum height of the ball. Indicate the units used in your answer.

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Turn over

3 **(a)** A parallelogram shape is to be laser-cut from a piece of sheet metal.

On a coordinate system the vertices of the parallelogram are O, A, B and C where O is the origin, C has coordinates (3, 4) and A has coordinates (1, 3).

In the parallelogram OABC, find

(i) the distance OC,

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.... **[2]**

(ii) the midpoint of AC,

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.... **[2]**

(iii) the coordinates of B.

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.... **[1]**

(b) The graph in Fig. 1 shows part of the curve $y = \cos x$.

On the graph draw the curve $y = \cos 2x$.
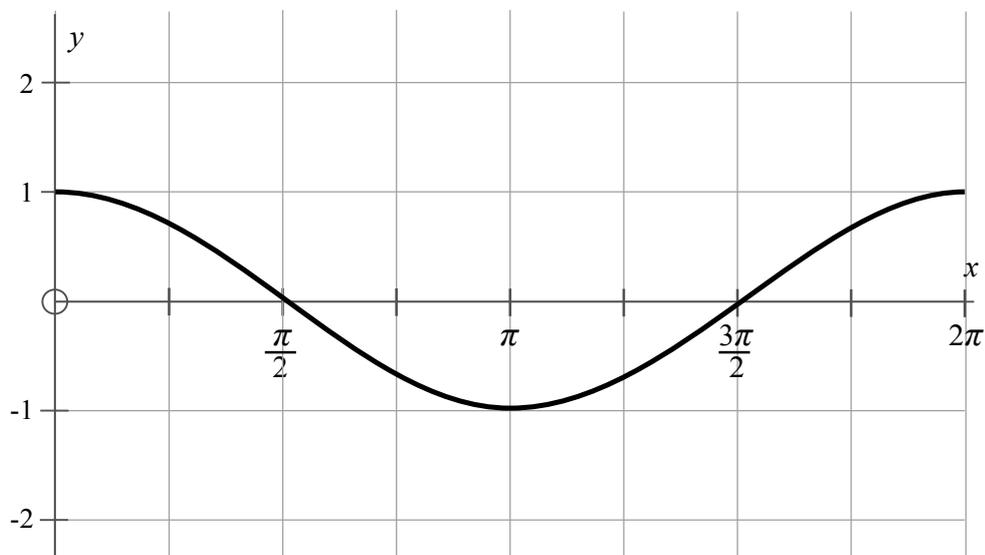
Fig. 1 **[2]**

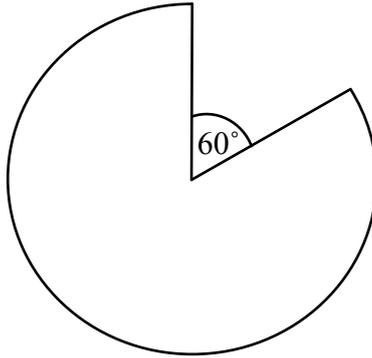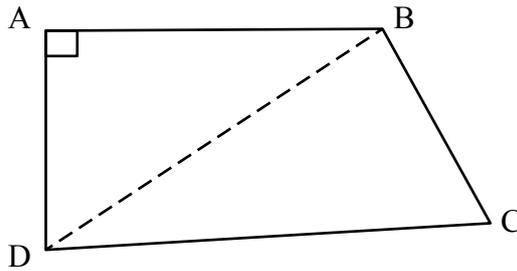**4 (a) (i)** Convert 2 radians to degrees.

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....**Turn over**

.... **[1]**

(ii) A circular lamina has the shape of a circle, radius 35 cm. A sector of the circle subtending an angle of 60^0 at the centre is removed.

Find the area of the remaining shape.

60°

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Turn over

(b) A plot of land, ABCD, is being surveyed. The shape is a quadrilateral. The lengths of the sides are: AB = 10 m, BC = 10 m, CD = 12 m and DA = 9 m. The angle at A is 90^0.

(i) Using Pythagoras' theorem, find the length DB, correct to 2 decimal places.

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(ii) Hence, using the cosine rule, find the angle at C, correct to 3 significant figures.

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5 **(a)** Find $\int (\cos 2x + 1)\, \mathrm{d}x$.

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(b) Find the equation of the tangent to the curve $y = x^3 - 4x + 5$ at the point with coordinates (2,5).

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.... **[4]**

Turn over for the next question

6 A 0.005 F capacitor is charged through a 2000 Ω resistor using a 12 V supply.

The voltage at time t seconds is given by the formula $V = 12(1 - e^{-kt})$. The constant $k = \dfrac{1}{RC}$ where R is the resistor value and C the capacitance.

(i) Show that $k = \dfrac{1}{10}$.

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(ii) Find the time taken for the potential difference across the plates to reach 10 volts.

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7   A quality control engineer has the task of checking the mass of steel bars that are produced on a machine, and which need to have a mean mass of 1000 grams.

On Monday a sample of 20 bars, chosen at random, are weighed to the nearest 10 grams.
The data are summarised in the table below.

Mass, m gram	$975 < m \leqslant 985$	$985 < m \leqslant 995$	$995 < m \leqslant 1005$	$1005 < m \leqslant 1015$	$1015 < m \leqslant 1025$
Frequency	2	5	6	5	2

(i) Explain why you can tell that the mean of the data is 1000 grams without doing any calculation.

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.... **[1]**

(ii) Find the standard deviation of the data.

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Turn over

During the course of the week the quality control engineer checks the masses of a large number of bars. He decides that the set of masses are approximately normally distributed with mean 1000 grams and standard deviation the same as for the 20 masses collected on Monday.

(iii) On the grid below, sketch a normal distribution curve with this mean and standard deviation. Scale the horizontal axis appropriately.
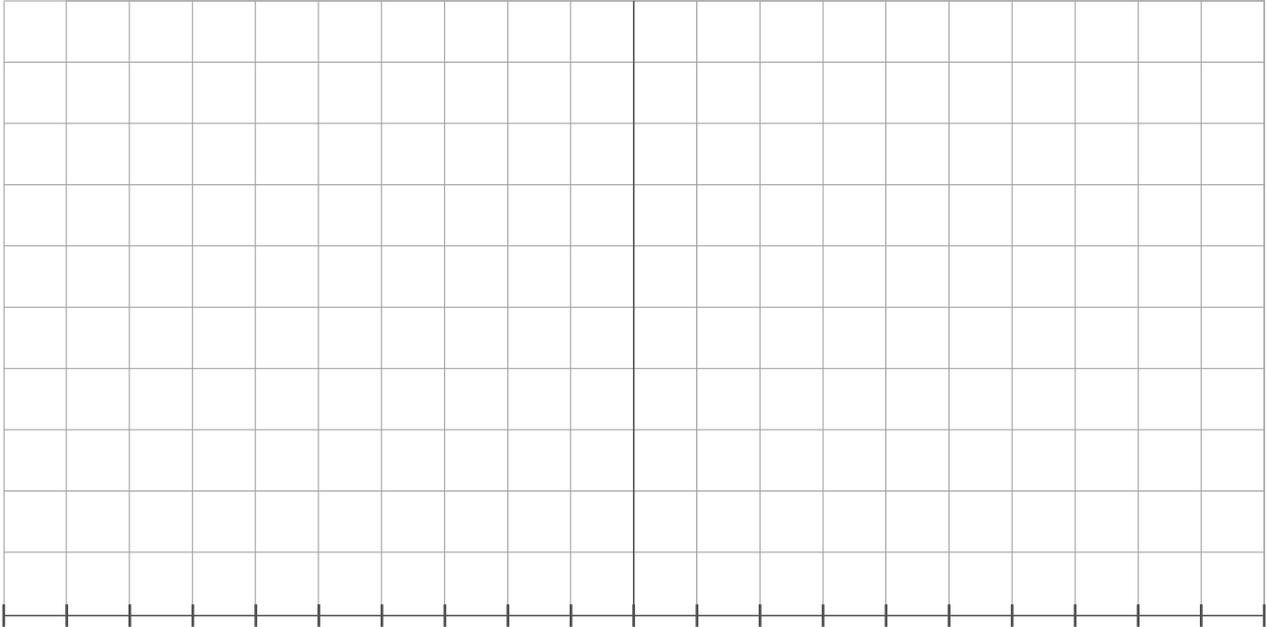
[2]

(iv) It is known that for a normal distribution approximately 95% of values lie within 2 standard deviations of the mean.

Find the range of values the quality control engineer should set so that 5% of bars will be rejected.

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.... **[2]**

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 – for example 1(d) or 6(i).

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