OCR
Oxford Cambridge and RSA

Wednesday 8 January 2020 – Afternoon

Level 3 Cambridge Technical in Engineering

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

Time allowed: 1 hour 30 minutes
C301/2001

C301_1_2001

You must have:
- the Formula Booklet for Level 3 Cambridge Technical in Engineering (inside this document)
- 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 can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space, use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working.
- Give your final answers to a degree of accuracy that is appropriate to the context.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- This document has **12** pages.

ADVICE
- Read each question carefully before you start your answer.

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

Answer **all** the questions.

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

.....

.....

.....

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

(b) Factorise $2x^3 - 4x^2$.

.....

.....

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

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

.....

.....

.....

.....

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

(d) **(i)** Factorise $f(x) = x^2 - 8x + 15$.

.....

.....

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

(ii) Hence solve the equation $f(x) = 0$.

.....

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

2 (a) (i) Show that $(x - 2)$ is a factor of the function $g(x) = x^3 - 2x^2 - x + 2$.

.....

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

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

.....

.....

.....

.....

.....

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

(b) 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 $K = \frac{1}{2}mv^2$.

Rearrange this formula so that v is the subject.

.....

.....

.....

.....

.....

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

3 **(a)** Find the equation of the line that passes through the points (1, 2) and (7, 5).

.....

.....

.....

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

(b) Find the equation of the line through the point (2, 1) which is parallel to the line $y = 3x - 1$.

.....

.....

.....

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

(c) **(i)** The points A and B have coordinates (1, 3) and (5, -3) respectively. Find the coordinates of the midpoint of AB.

.....

.....

.....

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

(ii) Calculate the distance AB.

.....

.....

.....

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

4 **(a)** A wheel in a machine is rotating at 5 radians per second.
Calculate this in revolutions per minute.

.....

.....

.....

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

(b) A corner support for a frame is a triangle ABC made of metal. In the triangle, angle A = 25 °, angle B = 90 ° and AC = 8 cm.

Find

(i) the length of the side BC,

.....

.....

.....

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

(ii) the area of the triangle.

.....

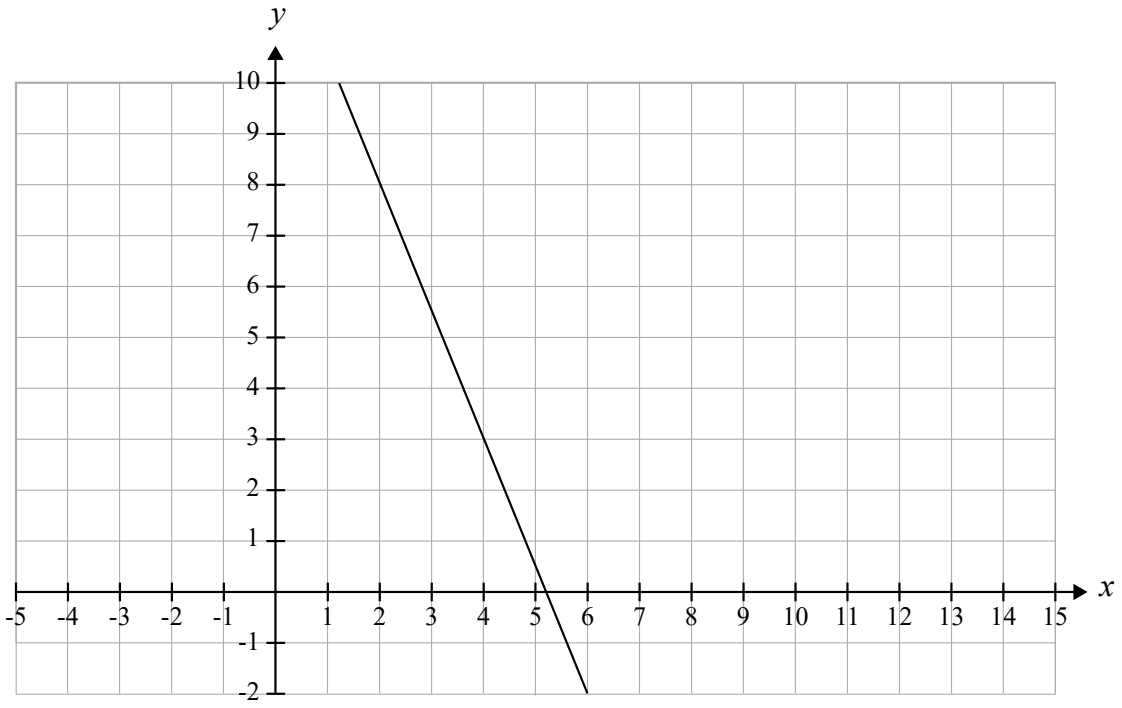
.....

.....

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

(c) Ahmed wants to find a value for x and y that satisfy two equations.
The equations that he has are $5x + 2y = 26$ and $y = x - 1$.

On the grid below is drawn the line $5x + 2y = 26$.



(i) On the same grid plot the line $y = x - 1$.

[2]

(ii) Using your graph, write down the values for x and y that satisfy both equations.

.....

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

5 A beaker of water used in an experiment is heated and removed from the heat when it has reached a temperature of 100 °C. The temperature of the water, T°C, after it has been removed from the heat is given by the formula

$$T = A + 80e^{-kt}$$

where t is the time in minutes and A and k are positive numbers.

(i) Write down the value of A.

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

(ii) What is the long-term temperature of the water?

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

(iii) After 10 minutes the temperature of the water is 70 °C. Show that $k = 0.0470$, correct to 3 significant figures.

.....

.....

.....

.....

.....

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

(iv) Find the temperature after 20 minutes.

.....

.....

.....

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

6 **(a)** Find $\int (x^2 + 4x^3)\, dx$

.....

.....

.....

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

(b) A sheet of metal, 60 cm wide is to be bent to form a trough with vertical sides AB and CD and horizontal base BC. The cross-section is to be symmetric with AB = CD = x cm, as shown in the diagram.

(i) Write down the length of the base, BC.

.....

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

(ii) Hence find an expression for the cross-sectional area of the trough.

.....

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

(iii) It is required to choose x so that the cross-sectional area is a maximum.

Using calculus, find the value of x that makes the cross-sectional area a maximum and find this area. Give the units for your answer.

.....

.....

.....

.....

.....

..... **[5]**

7 **(a)** Anita and Paul are quality control engineers and they are asked to sample a consignment of components that are packed in boxes each containing 10 components.

Anita decides to choose one box at random and check all 10 components in that box.

Paul chooses 10 boxes at random and then chooses one component at random from each box.

(i) State which one of them is using a random sampling method.

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

(ii) Say why the other sampling method is not random and may not be representative of the whole consignment.

.....

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

Paul and Anita weigh each of the components that they choose. One day Paul recorded the following masses, correct to the nearest gram.

Mass (gram)	25	26	27	28
Frequency	2	3	4	1

(iii) Write down the mode for these data.

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

(iv) Calculate the mean mass for this sample. A blank row has been added to the table for any intermediate working.

.....

.....

.....

.....

.....

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

(b) In a production line components are subject to a quality check. The probability of passing the quality check first time is 90%. If a component fails the first check it is reworked and then checked again. The probability of passing the second check is 70%.

Calculate the probability a component passes.

.....

.....

.....

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....