

Level 3 Cambridge Technical in Engineering

05822/05823/05824/05825

Unit 1: Mathematics for engineering

Sample Assessment Material

Date - Morning/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											

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. 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 **10** pages. Any blank pages are indicated.

Answer **all** questions.

- 1** (a) Remove the brackets and simplify $10(x - 3) + 5$.

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

- (b) Factorise the expression $x^2 - 16$.

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

- (c) Transpose the formula $R_1 = R_0(1 + \alpha t)$ to make α the subject.

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

- 2 (a) Fig.1 shows a load suspended from a crane.

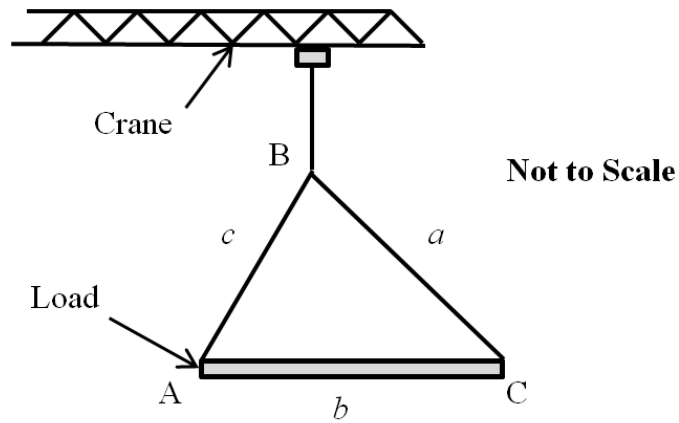


Fig. 1

In the triangle ABC shown in Fig.1, angle $A = 70^\circ$, angle $C = 40^\circ$ and side $a = 100$ mm.

Calculate the length of side c .

.....

.....

.....[3]

(b) In a triangle XYZ, angle $X = 60^\circ$, side $y = 100\text{mm}$ and side $z = 300\text{mm}$.

(i) Calculate the length of side x .

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

(ii) Find the area of the triangle XYZ.

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

3 In a workshop there are:

- ten machines of type A and four machines of type B that can manufacture a total of 450 components per week.

In another workshop there are:

- eight machines of type A and two machines of type B that can manufacture a total of 300 components per week.

- (i) Let a be the number of components that each machine of type A can manufacture per week and b be the number of components that each machine of type B can manufacture per week.

Write down **two** simultaneous equations from the given information.

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..... [2]

- (ii) Solve these equations to find the number of components each type of machine can manufacture per week.

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

- (iii) Show a suitable check to confirm the values of a and b you have found in part (ii) are correct.

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

- 4 (a) The side elevation of a section of a roller coaster track is in the form of a curve given by the equation $y = x^3 - 3x + 3$.

(i) Find the coordinates of the turning points of this curve.

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..... [5]

(ii) By finding the second derivative, determine which of these points is a maximum and which is a minimum.

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..... [3]

- (b) The force F N acting on an object at a distance x metres from a fixed point is given by

$$F = 5 + 4x + 6x^2.$$

Calculate the work done when the object moves from the position where $x = 2$ metres to the position where $x = 5$ metres.

In this case, Work done = $\int_2^5 F \, dx$.

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.....

..... [4]

5 (a) A lamina is a triangle ABC. On a coordinate system the coordinates of A, B and C are (7, 1), (6, 6) and (2, 0) respectively.

(i) By finding the distances AB and AC, show that the triangle is isosceles.

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

(ii) Find the midpoint, M, of BC.

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

(iii) Show that the lines BC and AM are perpendicular.

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

- (b) The voltage, v volts, across a C farads capacitor while it is being discharged through an R ohms resistor is given by $v = v_0 e^{-t/RC}$ where v_0 volts is the voltage across the capacitor before it begins to discharge and t seconds is the time after the capacitor begins to discharge.

Calculate the time, t , that elapses after the capacitor begins to discharge for v to reach 300 when $C = 40 \times 10^{-6}$, $R = 100 \times 10^3$ and $v_0 = 500$.

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..... [5]

- 6 (a) The diameters of 20 bars were measured with a micrometer giving the following results in mm, correct to the nearest 0.1 mm.

Diameter (mm)	Frequency
5.2	3
5.3	5
5.4	6
5.5	5
5.6	1

- (i) Calculate the mean diameter of the data.

.....

..... [2]

- (ii) Calculate the standard deviation of the data.

.....

.....

..... [3]

(iii) The diameter of 5.6 mm is excluded from the results.

State how the values of the mean **and** standard deviation previously calculated would change. You do not have to calculate the new values for the mean and standard deviation.

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

(b) In a large batch of glasses, 20% are defective.

If two glasses are chosen at random, calculate the probability that they are both defective.

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

END OF QUESTION PAPER



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SPECIMEN

Sample Assessment Material

Level 3 Cambridge Technicals in Engineering

UNIT 1: Mathematics for engineering

MARK SCHEME

Duration: 1 hour 30 minutes

MAXIMUM MARK 60

This document consists of 7 pages

Question		Answer	Mark	Guidance	
1	(a)	$10x - 30 + 5 = 10x - 25$	B1 B1	For $10x - 30$ For answer	
	(b)	$(x + 4)(x - 4)$	B1 B1	For $(x + 4)$ For $(x - 4)$	
	(c)	$R_1 = R_0(1 + \alpha t) \Rightarrow R_1 = R_0 + R_0\alpha t$ $\Rightarrow R_0\alpha t = R_1 - R_0$ $\Rightarrow \alpha = \frac{R_1 - R_0}{R_0 t}$ oe Alternative: $R_1 = R_0(1 + \alpha t) \Rightarrow \frac{R_1}{R_0} = 1 + \alpha t$ $\Rightarrow \alpha t = \frac{R_1}{R_0} - 1$ $\Rightarrow \alpha = \frac{R_1 - R_0}{R_0 t}$	B1 B1 B1	Expand Isolate Divide Divide B1 Isolate B1 For completion to final answer B1	Alternatives accepted, such as $\alpha = \frac{1}{t} \left(\frac{R_1}{R_0} - 1 \right)$

Question		Answer	Mark	Guidance	
2	(a)	$\frac{100}{\sin 70} = \frac{a}{\sin 40} \Rightarrow a = \frac{100 \sin 40}{\sin 70}$ $\Rightarrow a = 68.4 \text{ mm}$	M1 A1 A1	Correct use of sin rule Correct expression for a seen or implied	
	(b)	(i)	$x^2 = 100^2 + 300^2 - 2 \times 100 \times 300 \times \cos 60$ $\Rightarrow x^2 = 70000$ $\Rightarrow x = 265 \text{ mm}$	M1 A1 A1	Correct use of cosine rule For x^2 264.575. Accept 264.6
	(b)	(ii)	$\text{Area} = \frac{1}{2} 100h = \frac{1}{2} 100 \times 300 \sin 60$ $= 12990 \text{ mm}^2$ Alternative: $s = \frac{100 + 300 + \textit{their side}}{2} = 332.5$ $\Rightarrow \text{Area} = \sqrt{332.5(332.5 - 100)(332.5 - 300)(332.5 - 265)}$ $= 13023$	M1 A1 A1	Correct formula Correct substitution Accept 13 000 Correct use of formula M1 s A1 Final answer rounding to 13 000 A1

Question		Answer	Mark	Guidance
3	(i)	$10a + 4b = 450$ $8a + 2b = 300$	B1 B1	For one equation For the other
	(ii)	For e.g Eqn 1 divide by 2 $5a + 2b = 225$ $8a + 2b = 300$ Subtract $\Rightarrow 3a = 75 \Rightarrow a = 25$ Substitute: $2b = 225 - 125 = 100 \Rightarrow b = 50$	M1 A1 A1 M1 A1	Attempt to eliminate 2 eqns in right form For a To find b . Any acceptable method is allowed.
	(iii)	Substitute into both equations. i.e. $8 \times 25 + 2 \times 50 = 200 + 100 = 300$ $10 \times 25 + 4 \times 50 = 250 + 200 = 450$	M1 A1	

Question		Answer	Mark	Guidance	
4	(a)	(i)	$y = x^3 - 3x + 3 \Rightarrow \frac{dy}{dx} = 3x^2 - 3$	M1 A1	Diffn
			$= 0$ when $3x^2 = 3 \Rightarrow x^2 = 1$	M1 A1	Set = 0 and solve
			$\Rightarrow x = 1, -1$ $\Rightarrow y = 1, 5$ $\Rightarrow (1,1) (-1,5)$	A1	Must be given as coordinates
	(a)	(ii)	$\frac{dy}{dx} = 3x^2 - 3 \Rightarrow \frac{d^2y}{dx^2} = 6x$	M1 A1	Diffn
			When $x = 1, \frac{d^2y}{dx^2} > 1 \Rightarrow$ minimum		
			When $x = -1, \frac{d^2y}{dx^2} < 1 \Rightarrow$ maximum	A1	Both
	(b)		$\int_2^5 (5 + 4x + 6x^2) dx = [5x + 2x^2 + 2x^3]_2^5$	M1 A1	Integrate – ignore limits
			$= (25 + 50 + 250) - (10 + 8 + 16)$	M1 A1	Apply limits
			$= 291\text{Nm}$		

Question		Answer	Mark	Guidance	
5	(a)	(i)	$AB = \sqrt{(7-6)^2 + (6-1)^2} = \sqrt{1+5^2} = \sqrt{26}$ $AC = \sqrt{(7-2)^2 + (1-0)^2} = \sqrt{5^2+1} = \sqrt{26}$ Because $AB = AC$ the triangle is isosceles.	M1 A1 A1	Formula for distance Both
	(a)	(ii)	Midpoint, $M, = \left(\frac{6+2}{2}, \frac{6+0}{2} \right) = (4, 3)$	M1 A1	
	(a)	(iii)	$\text{Grad BC} = \frac{6-0}{6-2} = \frac{3}{2}$ $\text{Grad AM} = \frac{1-3}{7-4} = -\frac{2}{3}$ $\frac{3}{2} \times -\frac{2}{3} = -1 \Rightarrow$ perpendicular	M1 A1 A1	Finding gradients One of them correct Both gradients and property for perpendicular lines
	(b)		$RC = 100 \times 10^3 \times 40 \times 10^{-6}$ $\Rightarrow 300 = 500 \times e^{-\frac{t}{4}} \Rightarrow e^{-\frac{t}{4}} = 0.6$ $\Rightarrow \frac{t}{4} = 0.5108\dots$ $\Rightarrow t = 2.043\dots$	B1 B1 B1 M1 A1	For RC Correct substitution giving -0.2 Sight of 0.6 seen or implied

Question			Answer	Mark	Guidance
6	(a)	(i)	Sum = 107.6 Mean = 5.38	M1 A1	
	(a)	(ii)	Anything that rounds to 0.115	B3	If incorrect answer, mark workings as follows: M1 for method using either formulae A1 for intermediate step A1 for final answer
	(a)	(iii)	Mean would reduce Sd would reduce	B1 B1	
	(b)		P(def) = 0.2 P(2 def) = 0.2^2 = 0.04	B1 M1 A1	