



Thursday 16 January 2014 – Morning

**LEVEL 3 CERTIFICATE
ENGINEERING**

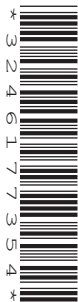
H865/01 Mathematical Techniques and Applications for Engineers

Candidates answer on the Question Paper.

OCR supplied materials:
None

Other materials required:
• Scientific calculator

Duration: 2 hours



Candidate forename		Candidate surname	
Centre number		Candidate number	

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions in **Section A** and any **three** questions from **Section B**.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are indicated.



**A calculator may
be used for this
paper**

2

SECTION A

Answer **all** questions in the spaces provided.

- 1 Remove the brackets and simplify the expression $3(2x - 5) - 4x$.

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

- 2 Factorise the expression $x^2 - 64$.

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

- 3 Simplify the expression $(x + 10)/5 - (x + 3)/4$.

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

- 4 Solve the equation $(3x + 4)/3 = (-2x - 6)/6$.

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

- 5 Define the term 'isosceles triangle'.

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

3

- 6 Sketch a graph of $y = \tan x$ for angles from $-\pi/2$ to $+\pi/2$ in the space below.

[2]

- 7 In a right angle triangle, angle $\theta = 45^\circ$.

Determine the length of one side of the triangle if the length of the hypotenuse is 1 m long.

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

- 8 Prove that $\tan x = \sec x / \operatorname{cosec} x$.

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

- 9 Differentiate $y = 4x^4 + 2 \sin x$ with respect to x .

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

- 10 Differentiate $y = 1/x + \cos x$ with respect to x .

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

- 11 Integrate $\cos 4x$ with respect to x .

.....

.....

..... [2]

- 12 Calculate the value of the definite integral $\int_2^3 4x^3 \, dx$.

.....

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..... [2]

- 13 Explain, with the aid of a diagram, what is meant by the term 'pie chart'.

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..... [2]

- 14 The diameters of five bars were measured giving the following results in millimetres:

26.25 26.00 26.40 26.60 26.15

Determine the arithmetic mean diameter.

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.....

..... [2]

- 15 With reference to probability, explain what is meant by the term 'dependent events'.

.....

.....

..... [2]

SECTION B

Answer any **three** questions in the spaces provided.

- 1 (a) Given that $Q = mc(t_2 - t_1)$.

Calculate the value of Q when $m = 10$, $c = 480$, $t_2 = 200$ and $t_1 = 20$.

.....

.....

..... [1]

- (b) Transpose the formula $Q = mc(t_2 - t_1)$ to make t_1 the subject.

.....

.....

..... [3]

- (c) Transpose the formula $A = B/(3C - B)$ to make B the subject.

.....

.....

.....

..... [4]

- (d) Given that $x = \sqrt{a^2 - b^2}$.

Transpose the formula to make b the subject.

.....

.....

.....

..... [2]

[Total: 10]

6

- 2 (a) By factorisation solve the equation $x^2 + 2x - 8 = 0$.

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.....

.....

..... [3]

- (b) When a mass is projected vertically upwards with an initial velocity u of 40 ms^{-1} its height s metres after a time t seconds is $s = ut - 0.5gt^2$.

The acceleration due to gravity g is 9.81 ms^{-2} .

Determine how long after it is projected the mass will first reach a height of 20 m.

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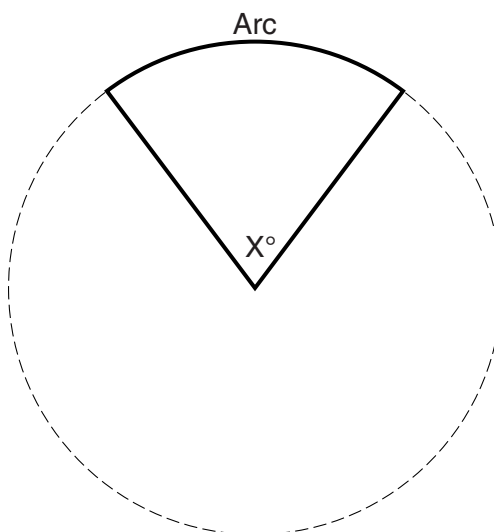
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..... [7]

[Total: 10]

7

- 3 An arc of a circle, of diameter 300mm, subtends an angle X of 75° at the centre as shown in Fig. 1.

**Fig. 1**

- (a) (i) Calculate the length of the arc.

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

- (ii) Calculate the area of the sector formed by the arc.

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

8

(b) In a triangle ABC, angle $A = 60^\circ$, side $b = 100$ mm and side $c = 180$ mm.

Calculate:

(i) the length of side a

.....

.....

.....

.....

.....

..... [4]

(ii) the area of the triangle.

.....

.....

.....

.....

..... [2]

[Total: 10]

- 4 (a) An electricity pylon stands on horizontal ground. At a point 75 metres from the base of the pylon, the angle of elevation to the top of the pylon is 25° .

Calculate the height of the pylon.

.....

.....

..... [2]

- (b) Two forces **A** and **B** act at a point **x** and are at right angles to each other.

Force **A** has a magnitude 30 N and acts along a bearing of 090° .

Force **B** has a magnitude 40 N and acts along a bearing of 000° .

- (i) Calculate the magnitude and bearing of the resultant force of **A** and **B**.

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..... [6]

- (ii) A third force **D** is now applied at point **X**. The three forces **A**, **B** and **D** are in equilibrium. State the magnitude of **D**, and give the bearing along which it acts.

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.....

.....

..... [2]

[Total: 10]

10

- 5 (a) (i) Differentiate $y = 6 \ln 4x$ with respect to x .

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

- (ii) Differentiate $y = 5/(e^{3t})$ with respect to t .

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

- (b) The distance s of a vehicle from a fixed point at time t seconds is $s = 120 e^{-t/4} + 30t - 120$ metres.

- (i) Calculate the distance s when $t = 3$ seconds.

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

- (ii) Calculate the velocity of the vehicle when $t = 4$ seconds.

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

- (iii) Calculate the time at which the velocity of the vehicle is 15 ms^{-1} .

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

[Total: 10]

- 6 (a) The gradient of a curve is given by the expression $\frac{dy}{dx} = 4x - 5$.

Determine the equation of the curve if it passes through the point (0,2).

.....

.....

.....

..... [2]

- (b) Find the area bounded by the curve $y = x^3 - 5x$, the x-axis, and ordinates $x = 0$, $x = 2$.

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..... [3]

- (c) Integrate $y = 4 \sin 5x + \sqrt{x}$ with respect to x .

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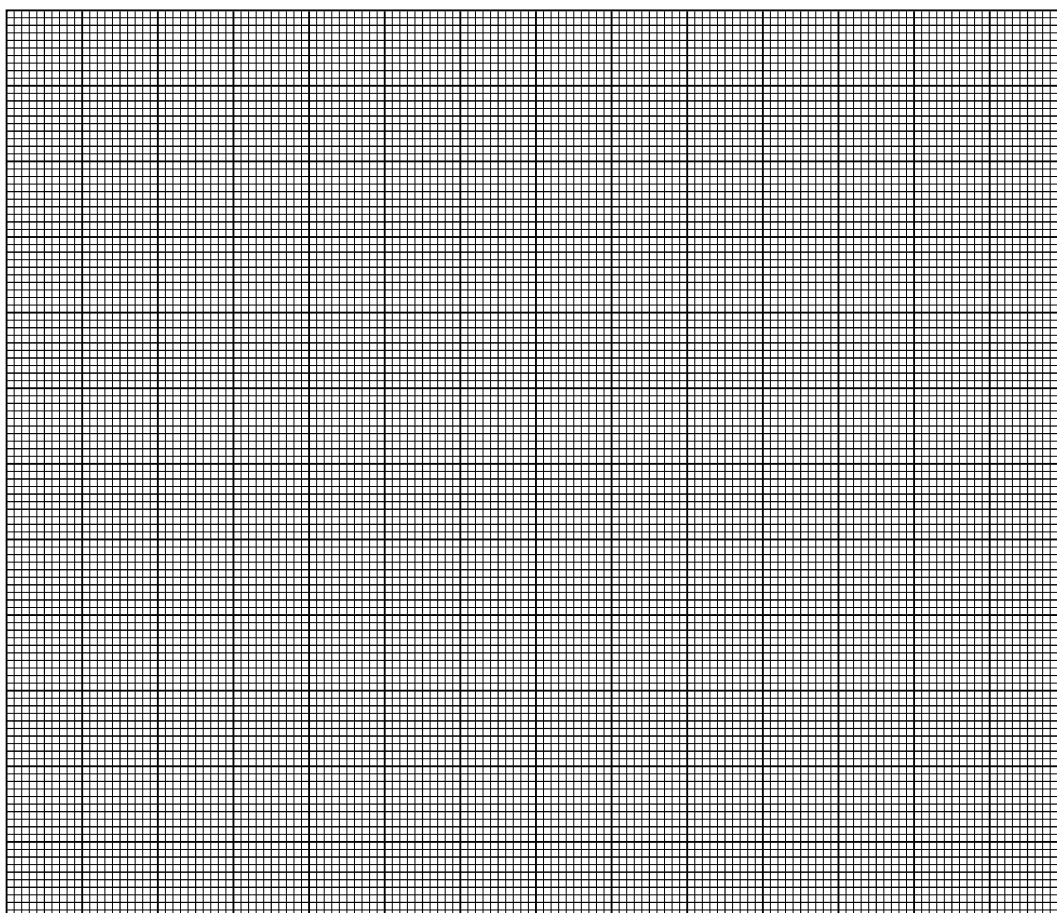
..... [5]

[Total: 10]

- 7 The following table shows time related information about 37 people working on an engineering task.

Time in minutes (t)	Frequency (f)	Class width	Frequency density
$0 \leq t < 5$	2	5	0.4
$5 \leq t < 15$	6		
$15 \leq t < 30$	12		
$30 \leq t < 40$	10		
$40 \leq t < 50$	7		

- (a) Complete the table for class width and frequency density. The first row has been completed for you. [2]
- (b) Draw a histogram to represent this information, on the grid below.



[6]

13

- (c) State whether the histogram is symmetrical, positively skewed, or negatively skewed.

..... [1]

- (d) Use the histogram to estimate the time mode.

..... [1]

[Total: 10]

- 8 (a) Explain what is meant by the term expectation in the context of probability.

.....

 [2]

- (b) With reference to probability explain what is meant by the term outcome.

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 [2]

- (c) The diagram in Fig. 2 shows a number of students studying mathematics, electronics and science.

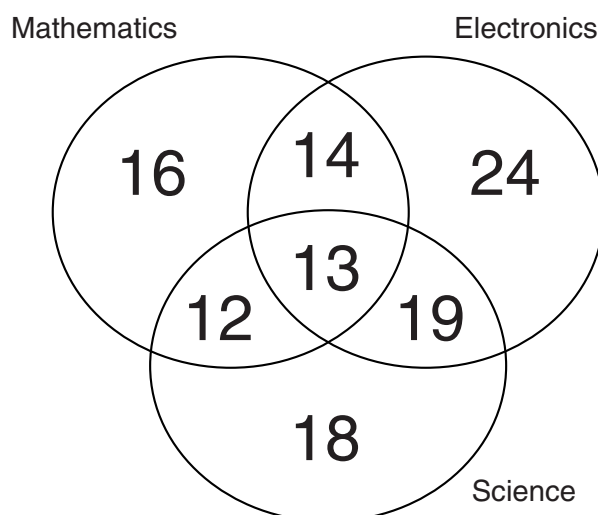


Fig. 2

- (i) Determine the total number of students.

..... [1]

- (ii) Determine the total number of students studying mathematics.

..... [1]

- (iii) Determine the total number of students studying only electronics.

..... [1]

15

(iv) Determine the number of students who study mathematics and electronics.

..... [1]

(v) Determine the number of students who study electronics and science.

..... [1]

(vi) Determine the number of students who study mathematics, electronics and science.

..... [1]

[Total: 10]

END OF QUESTION PAPER

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