

**PRINCIPAL LEARNING
LEVEL 3**

ENGINEERING

Mathematical techniques and applications for engineers

H865

Tuesday 18 January 2011

Afternoon

Duration: 2 hours

Candidates answer on the question paper.

OCR supplied materials:

None

Other materials required:

- Scientific calculator



Candidate forename		Candidate surname	
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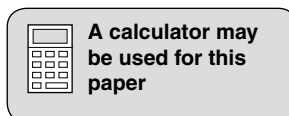
Centre number						Candidate number				
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INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- 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).
- Answer **all** the questions in **Section A** and any **three** questions from **Section B**.
- 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 **12** pages. Any blank pages are indicated.



Section A

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

- 1 Remove the brackets and simplify $10(x - 3)$.

.....
 [2]

- 2 Factorise the expression $x^2 - 16$.

.....
 [2]

- 3 Simplify the expression $(x + 5)/3 - (x + 2)/6$.

.....

 [2]

- 4 Solve the equation $4(x - 3) = 5x + 6$.

.....

 [2]

- 5 A chord of a circle of diameter 140 mm subtends an angle of 60° at the centre. Calculate, to one decimal place, the length of the minor arc.

.....

 [2]

- 6 In a right-angled triangle, ABC, where B is the right angle, length $a = 75$ mm and length $c = 250$ mm. Calculate, to the nearest degree, angle A.

.....

 [2]

7 Sketch, on the axes provided in Fig. 1 the curve $y = \sin \theta$ for values of θ from 0 to 360° .

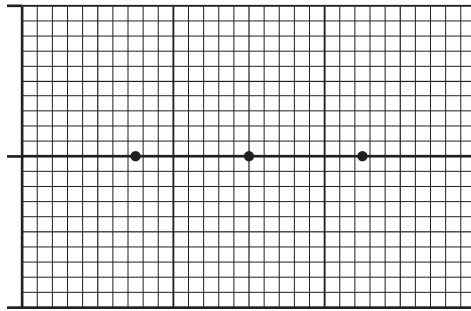


Fig. 1

[2]

8 In a right-angled triangle, the angle A is such that $\sin A = 3/5$. Find $\cos A$.

..... [2]

9 Differentiate $y = 2x^5 + 3x^4$ with respect to x.

.....

 [2]

10 Differentiate $y = e^{-2x} + \ln(3x)$ with respect to x.

.....

 [2]

11 Integrate $\cos x + \sin x$ with respect to x.

.....

 [2]

12 Integrate $\cos 5x$ with respect to x .

.....

 [2]

13 A normally distributed variable has a mean of 74 and a standard deviation of 6.

Calculate the standardised score for:

(a) 86

.....

(b) 65

..... [2]

14 Determine the mean and mode for the set of given values:

7, 7, 11, 9, 10, 10, 10, 12, 8 and 8

.....

 [2]

15 An electrician has three good fuses and five blown fuses in a box. The electrician picks out a fuse at random.

Write down the probability that:

(a) a good fuse is chosen

.....

(b) a blown fuse is chosen.

..... [2]

Section B

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

- 1 (a) The volume of a sphere is given by $V = (4\pi R^3)/3$.
Calculate, to one decimal place, the volume of the sphere when $R = 9$ m.

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

- (b) (i) Transpose the formula $V = (4\pi R^3)/3$ to make R the subject.

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

- (ii) Calculate the value of R, to one decimal place, when the volume V is 1000 mm^3 .

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

- (c) The impedance of a circuit is given by $Z = \sqrt{R^2 + X^2}$.
Find the resistance R in terms of impedance Z and reactance X.

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

[Total: 10]

- 2 (a) The total surface area of a closed cylinder is 4400 mm^2 .
If the diameter of the cylinder is $d \text{ mm}$ and the height h is 260 mm , and assuming π is $22/7$,
show that:

$$d^2 + 520d - 2800 = 0$$

.....

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..... [5]

- (b) Solve the equation $d^2 + 520d - 2800 = 0$ to determine the diameter d of the cylinder correct to two decimal places.

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..... [5]

[Total: 10]

- 3 The angles of elevation of the top of a vertical mast XY from two points A and B on the same level as its foot X are 32° and 22° respectively.
The height of the mast is 18m and the bearings of A and B from X are 260° and 210° respectively.

Calculate:

- (a) to one decimal place, distance AX.

.....
.....

[2]

- (b) to one decimal place, distance BX.

.....
.....

[2]

- (c) angle AXB.

.....

[1]

- (d) to one decimal place, distance AB.

.....
.....
.....
.....
.....

[3]

- (e) to the nearest degree, angle XAB.

.....
.....
.....

[2]

[Total: 10]

4 (a) Draw a labelled diagram of a right-angled triangle ABC where angle B is the right angle.

[1]

(b) Using the information shown on your triangle, prove from first principles that $\tan A = \sin A / \cos A$.

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

(c) (i) Solve, to the nearest degree, the equation $\sin^2\theta - \cos^2\theta = 0.25$ for an angle between 0 and 90°.

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

(ii) Find other solutions for angles between 90 and 360°.

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

[Total: 10]

5 For the curve given by the equation $y = x^3 + 3x^2 - 24x$ determine

(a) values for x at which its gradient is zero.

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

(b) the corresponding values of y .

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

(c) the local maximum and minimum turning points

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

[Total: 10]

6 (a) After t seconds, a vehicle has a velocity $v = (4 + 6t)$ metres per second.

(i) Calculate how far the vehicle moves in the first 4 seconds if distance $s = \int_{t_1}^{t_2} v \, dt$.

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

(ii) Calculate the distance moved in the fifth second.

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

(b) Find, correct to one decimal place, the area enclosed between the curve $y = x^2 + 4$ and the straight line $y = 24 - x$.

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..... [6]

[Total: 10]

7 The table below gives the times taken for 34 employees to travel to work.

Time in minutes (t)	Frequency (f)	Class width	Frequency density
$0 \leq t < 10$	5	10	0.5
$10 \leq t < 15$	8		
$15 \leq t < 20$	6		
$20 \leq t < 30$	10		
$30 \leq t < 45$	3		

(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 axes provided.

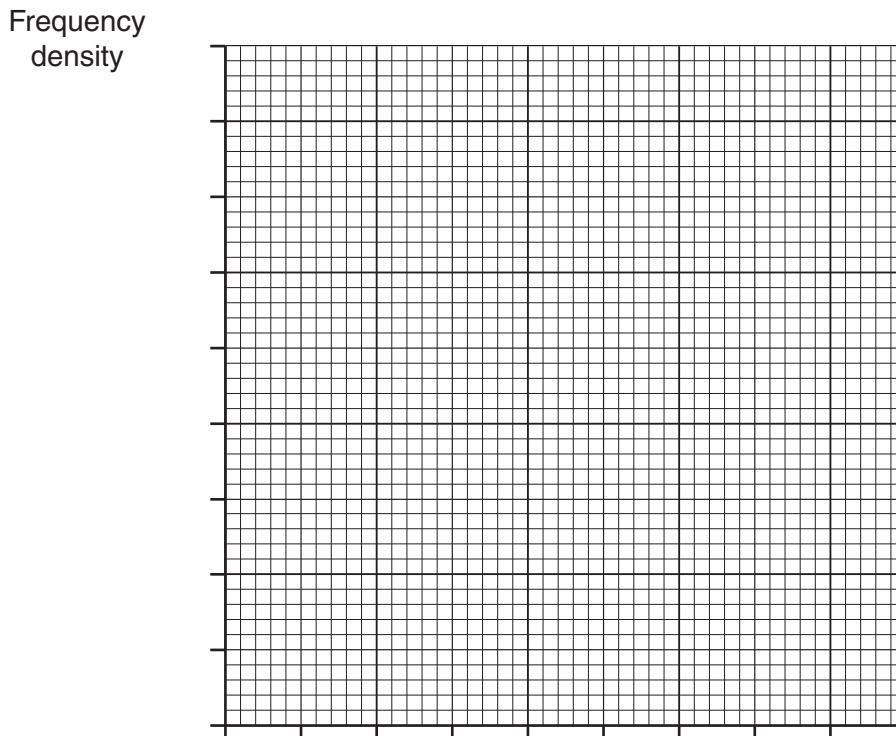


Fig. 2

[4]

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

..... [1]

(d) Write down the modal group.

..... [1]

(e) Use the histogram and modal group to find an estimate of the mode.

..... [2]

[Total: 10]
Turn over

8 The marks awarded by an examiner, out of a maximum of 60, in a recent examination are:

56, 58, 58, 56, 30, 57, 56, 57, 54, 58

- (a) Complete the table below correct to two decimal places.
Calculate the mean value, the variance and the standard deviation of the examination marks.

Examination mark (x)	Frequency (f)	fx	x – mean	(x – mean) ²	f(x – mean) ²
30	1	30			
54					
56					
57					
58					

.....

 [8]

- (b) If the mark of 30 is excluded from the results state what effect this would have on the values for the mean and standard deviation previously calculated.
You are not expected to calculate the new values for the mean and standard deviation.

.....
 [2]

[Total: 10]



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