

OCR

Oxford Cambridge and RSA

Thursday 14 January 2016 – 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 **20** pages. Any blank pages are indicated.



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

2

SECTION A

Answer **all** questions.

- 1 Remove the brackets and simplify the expression $4 + 5(6x - 7) + 3x$.

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

- 2 Factorise the expression $x^2 - 11x + 30$.

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

- 3 Simplify the expression $(3x - 4)/5 - (6x + 7)/8$.

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

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

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

- 5 Two sides of a triangle ABC are $b = 8\text{m}$ and $c = 10\text{m}$.

Calculate the area of the triangle if angle $A = 70^\circ$.

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

- 6 Using complementary angles show that $\sin 20^\circ / \cos 70^\circ = 1$.

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

- 7 (a) Convert 30° to radians.

..... [1]

- (b) Convert $3\pi/4$ radians to degrees.

..... [1]

- 8 The sides of a right-angled triangle ABC are $a = 13\text{m}$, $b = 5\text{m}$ and $c = 12\text{m}$.

Calculate angle C.

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

- 9 Differentiate $y = 6 \cos 3x$ with respect to x .

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

- 10 Differentiate $y = 5 \ln 4x$ with respect to x .

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

- 11 Integrate $\sqrt{x}^3$ with respect to x .

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

- 12 Determine the area between the curve $y = x^2$ and the x -axis between $x = 0$ and $x = 30$.

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

4

- 13** Find the median of the following set of numbers:

3 2 7 1 9 6

.....

.....

..... [2]

- 14** A box contains three tins of black paint and five tins of blue paint.

An engineer picks out two tins of paint at random.

Calculate the probability that the engineer picks out two tins of the same coloured paint.

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..... [2]

- 15** Explain what is meant by the term 'quartile'.

.....

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..... [2]

[Total: 30]

5

SECTION B

Answer any **three** questions.

- 1 (a) The surface area of a cylinder is given by the formula $A = (\pi d^2/2) + \pi dh$.

Calculate the surface area of the cylinder when $d = 50$ and $h = 200$.

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..... [2]

- (b) Transpose the formula $T = 2\pi \sqrt{L/g}$ to make g the subject.

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..... [4]

- (c) Transpose the formula $x = ab/(c + bd)$ to make b the subject.

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..... [4]

[Total: 10]

6

- 2 (a) In an engineering process two variables x and y are related by the equations

$$(4/x) - (1/y) = 13$$

$$(3/x) - (2/y) = 6$$

- (i) Determine the values of x and y .

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..... [6]

- (ii) Carry out a check to confirm that the values you have found for x and y are correct.

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..... [1]

- (b) Solve the equation $5(3a - 6) - 4(6a - 4) = 8 - (2a + 1)$.

.....

.....

.....

..... [3]

[Total: 10]

7

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Question 3 begins on page 8

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8

- 3 Fig. 1 shows an engineering company logo made up of two right-angled triangles and a sector of a circle.

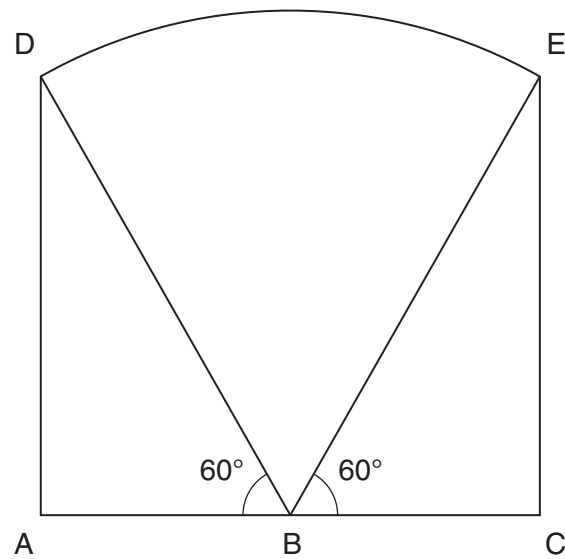


Fig. 1

Length AB = length BC = 80 mm.

Calculate:

- (a) the length AD

.....

.....

..... [2]

- (b) the length BD

.....

.....

..... [2]

- (c) length of the arc DE

.....

.....

..... [2]

(d) the area of triangle BEC

.....

.....

..... [2]

(e) the area of the sector of the circle.

.....

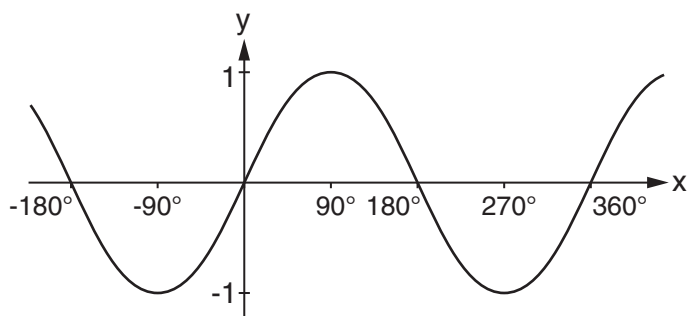
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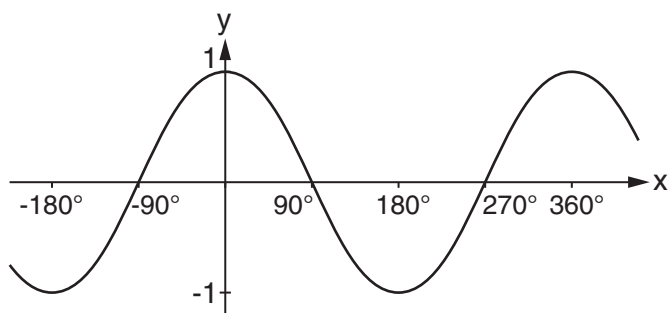
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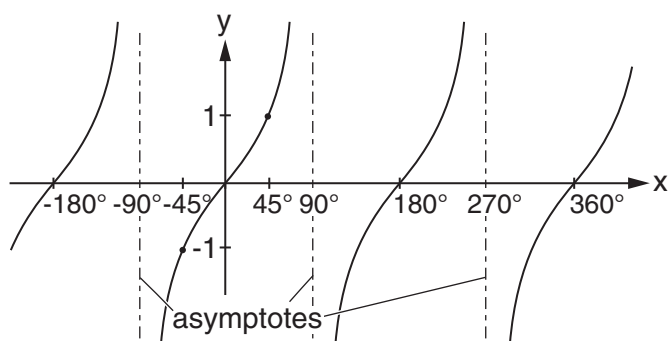
- 4 (a) Fig. 2 shows three graphs of elementary trigonometric functions. In each case state the name of the function in the space provided to the right of the graph.



y =



y =



y =

Fig. 2

[3]

11

(b) Prove that $\sin^2 x (\operatorname{cosec}^2 x + \sec^2 x) \equiv 1/\cos^2 x$.

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..... [7]

[Total: 10]

12

- 5 Fig. 3 shows the cross-section of an empty water container, shaped in the form of an isosceles triangle.

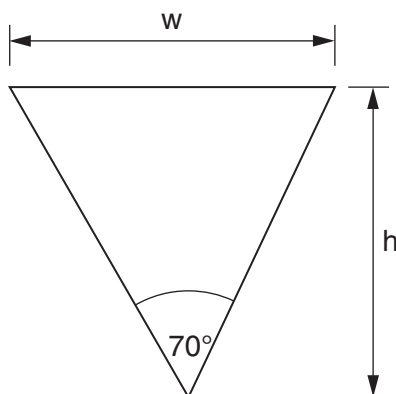


Fig. 3

- (a) Determine a formula for width w in terms of height h .

.....

 [2]

- (b) The length of the container is 6 m. Determine a formula for the volume V of the container in terms of height h .

.....

 [2]

- (c) Differentiate the formula for volume V found in part 5(b) with respect to height h .

.....
 [1]

13

- (d) Water starts to flow into the empty container at a rate of $1\text{ m}^3 \text{ min}^{-1}$.

Given $dV/dt = (dV/dh) \times (dh/dt)$, calculate the rate at which the depth of the water is increasing at the end of five minutes.

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..... [5]

[Total: 10]

14

- 6 (a) Integrate $3x^2 + 6\sqrt{x} - (8/x^2)$ with respect to x .

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..... [4]

- (b) Evaluate the definite integral $\int_0^{\pi/2} (\sin 4x - \cos 4x) dx$.

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..... [6]

[Total: 10]

15

- 7 (a) The table shows the number of hours worked by 100 employees in one week.

Hours per employee	40	41	42	43	44	45
Number of employees	10	14	19	23	21	13

Complete the table below:

Hours per employee ie. raw score (x)	Number of employees ie. frequency (f)	fx	mean	x – mean	(x – mean) ²	f(x – mean) ²
40	10					
41	14					
42	19					
43	23					
44	21					
45	13					
	$\Sigma f =$	$\Sigma fx =$	Mean = $\Sigma fx / \Sigma f =$			$f(x - \text{mean})^2 =$

[7]

- (b) Calculate the variance and standard deviation using your results from part (a).

Variance

.....

 [2]

Standard deviation

.....

 [1]

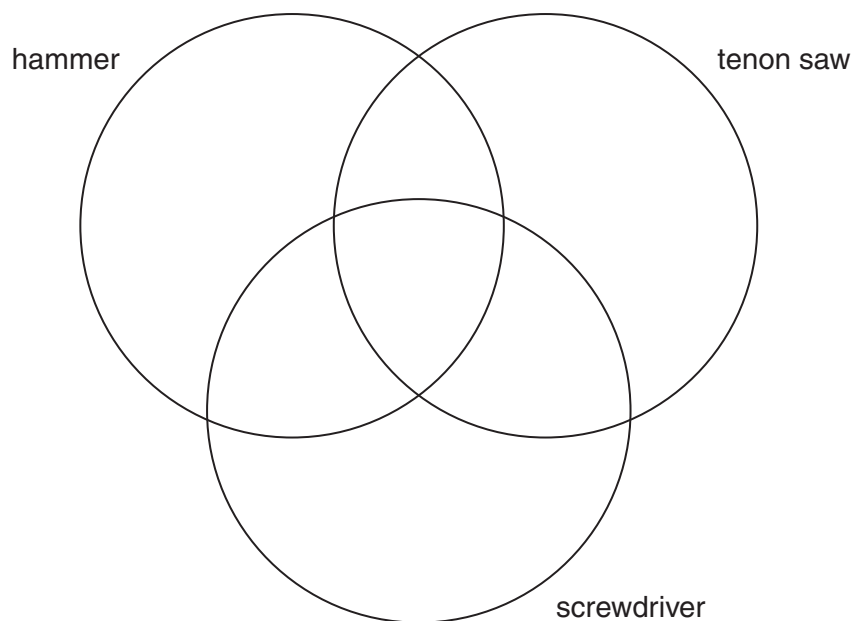
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16

- 8 A survey was taken using a sample of 50 engineers asking about tools that they owned. The results below show the distribution of tools owned.

28 owned a hammer
 37 owned a tenon saw
 12 owned a screwdriver
 2 owned a tenon saw and a screwdriver
 18 owned a hammer and a tenon saw
 9 owned a hammer and a screwdriver
 3 owned all three tools.

- (a) Complete the diagram below to represent this information.



[7]

- (b) State how many of the 50 engineers did not own any of the three tools listed.

.....
 [1]

- (c) One engineer is chosen at random.

Determine the probability that this engineer owns:

- (i) at least one of the three tools

.....
 [1]

- (ii) either only a hammer or only a tenon saw or only a screwdriver.

.....
 [1]

[Total: 10]

END OF QUESTION PAPER

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