

OCR

Oxford Cambridge and RSA

Thursday 15 January 2015 – 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 $6(4x + 5) - 8x$.

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

- 2 Factorise the expression $x^2 - 10x + 24$.

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

- 3 Simplify the expression $[(x + 5)/12] - (x - 4)/3$.

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

- 4 Solve the equation $5(2x - 4) = 3(3x - 2)$.

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

- 5 (a) Convert π radians to degrees.

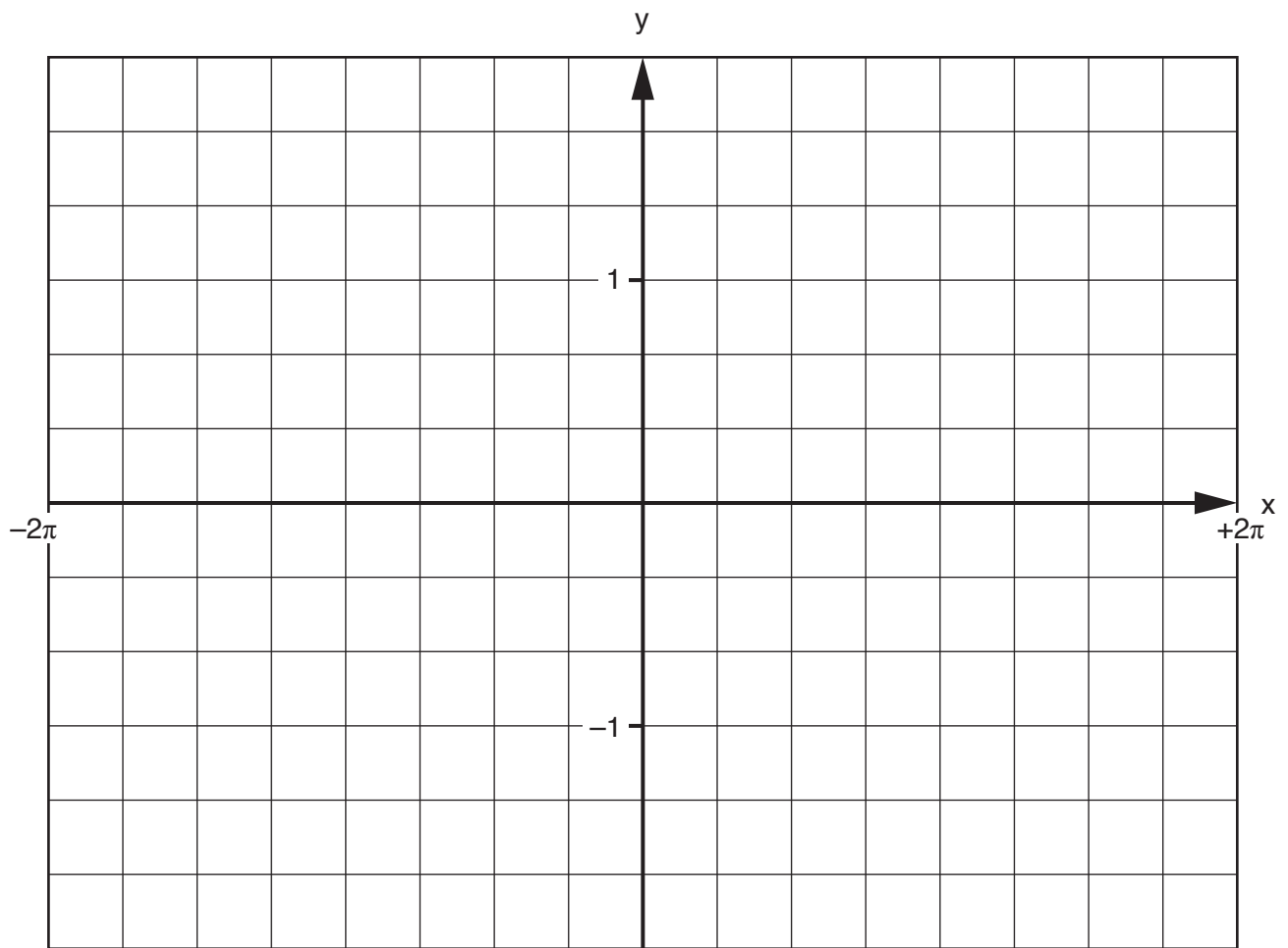
..... [1]

- (b) Convert 60° to radians.

..... [1]

3

- 6 **Sketch** a graph of $y = \sin x$ for angles from -2π to $+2\pi$ on the grid below.



[2]

- 7 In the triangle ABC angle $A = 30^\circ$, angle $B = 70^\circ$ and side $b = 2$ m.

Calculate the length of side a.

.....

 [2]

- 8 In a right-angled triangle the sine of angle x is $4/5$.

Draw the triangle and find the exact value of $\tan x$.

.....

 [2]

- 9 Differentiate $y = \sqrt{x^3}$ with respect to x .

.....

.....

..... [2]

- 10 Differentiate $y = 2e^{6x} + \sin x$ with respect to x .

.....

.....

..... [2]

- 11 Integrate $\sin 3x$ with respect to x .

.....

.....

..... [2]

- 12 Calculate the value of the definite integral $\int_1^3 15x^4 \, dx$.

.....

.....

.....

..... [3]

5

13 Name the curve shown in Fig. 1.

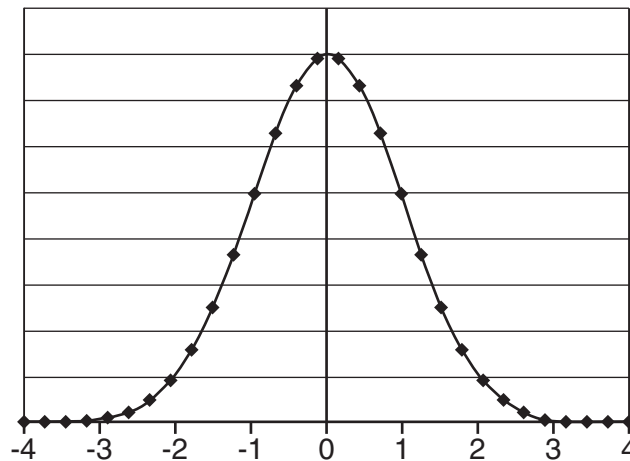


Fig. 1

..... [1]

14 Determine the arithmetic mean and the median for the set of ungrouped data given:

30 27 26 28 29

.....

 [2]

15 Given the probability law $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, state the meaning of:

$P(A \text{ or } B)$
 [1]

$P(A \text{ and } B)$
 [1]

[Total: 30]

SECTION B

Answer any **three** questions.

- 1 (a) Given that $A = \pi d^2/4$.

Calculate the value of A when $d = 10$.

.....

.....

..... [1]

- (b) Transpose the formula $V = V_0(1 + 3aT)$ to make T the subject.

.....

.....

.....

..... [3]

- (c) Transpose the formula $F = m(V^2 - U^2)/2$ to make U the subject.

.....

.....

.....

..... [3]

- (d) Given that $y = x/(x + 1)$.

Transpose the formula to make x the subject.

.....

.....

.....

..... [3]

[Total: 10]

7

- 2 (a) Currents I_1 and I_2 in a circuit are related by the equations:

$$0.5 I_1 + 0.6 I_2 = 7$$

$$1.2 I_1 + 0.4 I_2 = 9$$

Use these simultaneous equations to determine values for I_1 and I_2 .

.....

.....

.....

.....

.....

..... [5]

- (b) The formula for a rotating shaft turning through an angle θ in time t seconds is given by:

$$\theta = \tilde{\omega}t + 0.5\alpha t^2.$$

Calculate the time t taken when θ is 5 radians, $\tilde{\omega}$ is 4 radians s^{-1} and α is 0.6 radians s^{-2} .

.....

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.....

.....

..... [5]

[Total: 10]

8

- 3 (a) An alternating current is represented by $i = I \sin 314.2 t$.

Determine:

- (i) the frequency f of the supply in hertz

.....
 [1]

- (ii) the instantaneous current i when the peak current $I = 20 \text{ A}$ at a time of 0.002 s

.....

 [2]

- (iii) the peak current I when the instantaneous current i is 4 A at a time of 0.008 s .

.....

 [3]

- (b) The sides of a triangle ABC are $a = 3 \text{ m}$, $b = 5 \text{ m}$ and $c = 6 \text{ m}$.

Calculate:

- (i) the angle B

.....
 [2]

- (ii) the area of the triangle.

.....

 [2]

[Total: 10]

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Question 4 begins on page 10

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10

- 4 (a) Solve the equation $\sin^2 x - \cos^2 x = \frac{1}{4}$ for angles x between 0 and 360° .

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..... [5]

- (b) Fig. 2 shows the details of a door wedge. The faces $ACFD$, $ABED$ and $CBEF$ are rectangles.

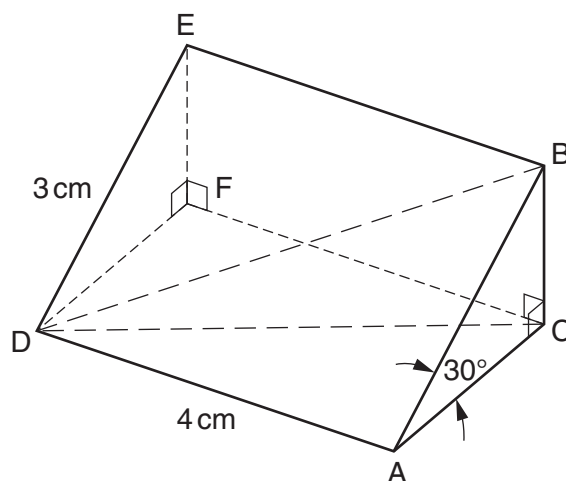


Fig. 2

Calculate:

- (i) the length of AC

.....

.....

..... [1]

- (ii) the length of BC

.....

.....

..... [1]

11

(iii) the angle between the lines DA and DC

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

(iv) the length of DC

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

(v) the angle between the lines DC and DB.

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

[Total: 10]

12

- 5 (a) Complete the table below for the equation $y = x^2$ for values of x from -2 to $+2$.

x	-2	-1.5	-1	0	1	1.5	2
y							

[1]

- (b) Fig. 3 shows a pair of axes.

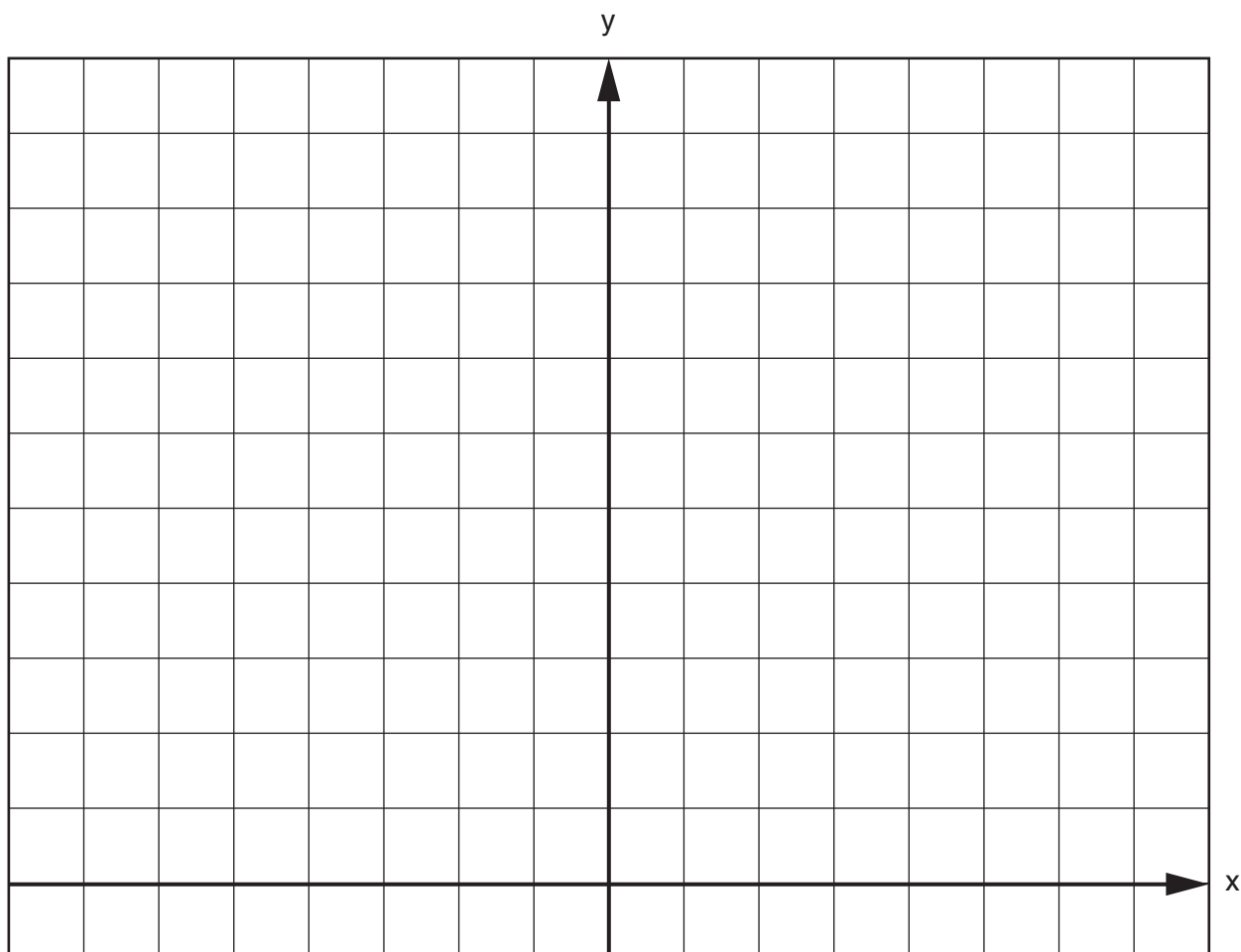


Fig. 3

- (i) Using the values from the completed table draw a graph on Fig. 3 of $y = x^2$ for values of x from -2 to $+2$. [2]
- (ii) Draw a tangent to the graph at the point when $x = -1.5$ and then determine the gradient of the curve at this point.

..... [1]

13

(c) The distance s metres moved by a body in t seconds is given by the formula $s = 2t^3 + 4t^2 + 6t$.

(i) Determine the initial velocity of the body.

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

(ii) Determine the velocity of the body after 5 seconds.

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

(iii) Determine the acceleration of the body after 3 seconds.

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

[Total: 10]

- 6 (a) Calculate the area bounded by the curve $y = \cos 3x$ and the x-axis between $x = 0$ and $x = \pi/6$.

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..... [4]

- (b) Integrate $y = (1 - x)^2$ with respect to x .

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.....

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..... [2]

- (c) Integrate $y = (x^3 - 2x)/3x$ with respect to x .

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 10]

15

- 7 (a) The time taken, in minutes, by 30 people to complete a task in a workshop gave the following results:

26 23 52 48 33 51 52 37 39 23
 44 54 21 29 37 59 26 39 29 21
 40 31 45 52 26 31 39 33 60 48

- (i) Complete the tally table below for the given times.

Time (minutes)	Tally	Frequency (f)
21 – 30		
31 – 40		
41 – 50		
51 – 60		

[2]

- (ii) Draw a histogram to represent the information from the tally table, on the grid below.

20.5

30.5

40.5

50.5

60.5

[4]

- (b) Fig. 4 shows a cumulative frequency curve for the time taken by 40 people to complete a different task in the workshop.

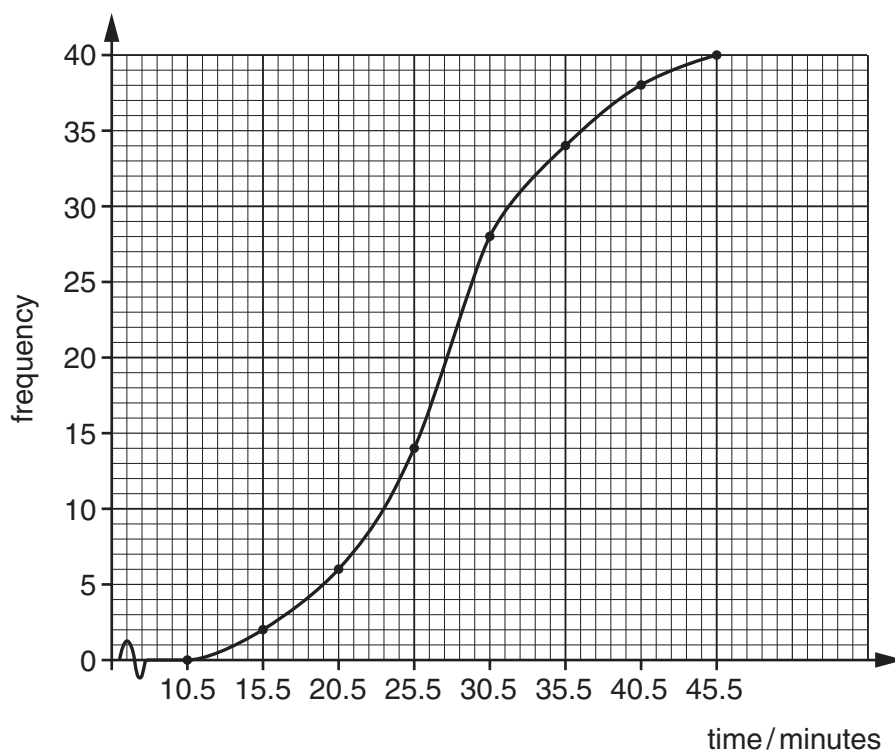


Fig. 4

- (i) Estimate the first and third quartile.

First quartile =

Third quartile =

[2]

- (ii) Estimate the interquartile range.

..... [2]

[Total: 10]

8 (a) With reference to probability, give the meaning of the terms:

(i) Trial

.....

.....

(ii) Outcome

.....

.....

(iii) Event.

.....

.....

[3]

(b) An engineering organisation has decided to give each of its clients an eight-character code. The first three characters in this code are the letters X, Y and Z in any order and the remaining five are the digits 1 to 5 in any order. Each letter and each digit can only occur once. Determine how many clients the organisation can code in this way.

.....

..... [2]

(c) When three six-sided dice are shaken and then thrown together, what is the probability of obtaining:

(i) three fives

.....

..... [1]

(ii) only one five

.....

..... [2]

(iii) at least one five?

.....

..... [2]

[Total: 10]

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