



Oxford Cambridge and RSA

Wednesday 20 May 2015 – Afternoon

**LEVEL 3 CERTIFICATE
ENGINEERING**

H865/01 Mathematical Techniques and Applications for Engineers



Candidates answer on the Question Paper.

OCR supplied materials:

None

Duration: 2 hours

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. 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 scientific
calculator may be
used for this paper

SECTION A

Answer **all** questions.

1 Remove the brackets and simplify the expression $6x - (8x + 5)$.

.....
.....

[2]

2 Factorise the expression $x^2 + 5x - 14$.

.....
.....

[2]

3 Simplify the expression $[(x + 4)/8] - (x - 5)/2$.

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

[2]

4 Solve the equation $6(3x - 5) = 2(4x - 7)$.

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

[2]

5 (a) Convert $\pi/3$ radians to degrees.

.....

[1]

(b) Convert 120° to radians.

.....

[1]

6 Name the wave form shown on the grid in Fig. 1 below.

..... [1]

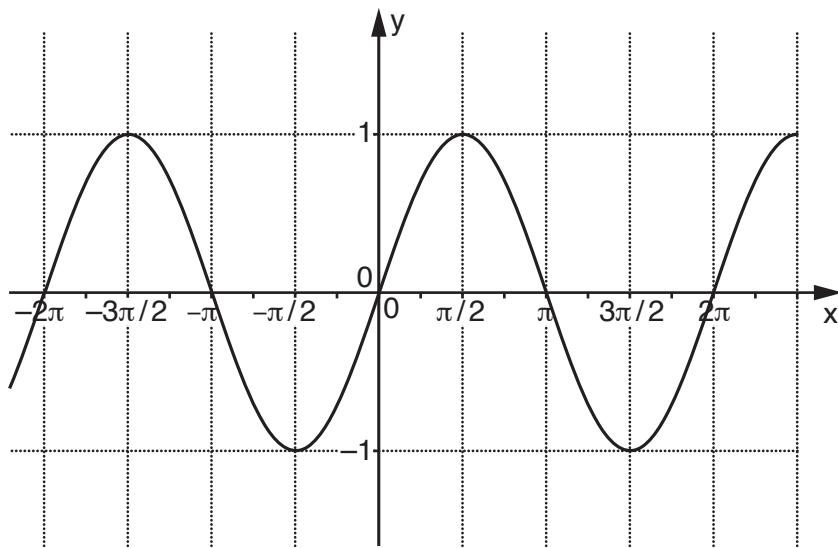


Fig. 1

7 In the triangle ABC, angle A = 30° and the length of side 'a' = 100 mm. Angle B is a right angle.

Calculate angle C and the length of side 'c'.

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

8 In a right angled triangle the cosine of angle x is 3/5.

Draw the triangle and find the exact value of sine x.

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

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

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

10 Differentiate $y = \sin x + (1/x)$ with respect to x.

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

[2]

11 Integrate $2 \sin 5x$ with respect to x.

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

[2]

12 Calculate the value of the definite integral $\int_2^5 4x^3 dx$.

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

[3]

13 Explain, with the aid of a diagram, what is meant by the term 'skew' in a distribution curve.

.....
.....

[2]

14 Determine the mode and the median point for the set of ungrouped data given:

6 9 7 11 8 10 6

Mode = [1]

Median = [1]

15 State the meaning of the parts of the following probability law listed:

$$P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

$P(A)$
..... [1]

$P(B)$
..... [1]

[Total: 30]

SECTION B

Answer any **three** questions.

1 (a) Given that $W = (mv^2)/2$.

Calculate the value of W when $m = 5$ and $v = 10$.

.....
.....

[1]

(b) Transpose the formula $A = B(1 + 2CD)$ to make C the subject.

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

[3]

(c) Transpose the formula $v^2 = u^2 + 2as$ to make u the subject.

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

[2]

(d) Given that $A = B/(B + 2)$.

Transpose the formula to make B the subject.

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

[4]

[Total: 10]

2 (a) The area of a triangle is 1000 mm^2 and its base is 40 mm long. Calculate its perpendicular height.

..... [2]

(b) The length of the sides of triangle XYZ are $x = 8\text{ m}$, $y = 10\text{ m}$ and $z = 12\text{ m}$. Calculate the area of the triangle.

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

(c) Calculate the area of a triangle ABC when angle B = 30° , side a = 12 m and side c = 16 m.

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

[Total: 10]

3 (a) A vehicle is moving in a straight line. The distance 's' metres moved in 't' seconds is given by $s = 60(20e^{-t/20} + t - 20)$.

Determine the acceleration of the vehicle after 10 seconds.

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

• [4]

(b) The surface area 'S' of a particular cylindrical water tank is given by $S = 2\pi r^2 + 400/r$ where r is the radius.

Calculate the radius of the tank that will give the minimum surface area.

[61]

[Total: 10]

4 (a) The time taken, in minutes, to carry out 50 engineering processes in a workshop was recorded.

(i) Complete the cumulative frequency column in the table below.

Time (minutes)	Tally	Cumulative frequency
$0 < t \leq 20$	8	
$20 < t \leq 40$	18	
$40 < t \leq 60$	15	
$60 < t \leq 80$	5	
$80 < t \leq 100$	3	
$100 < t \leq 120$	1	

[1]

(ii) Use the grid in Fig. 2 to draw a cumulative frequency diagram for this data.

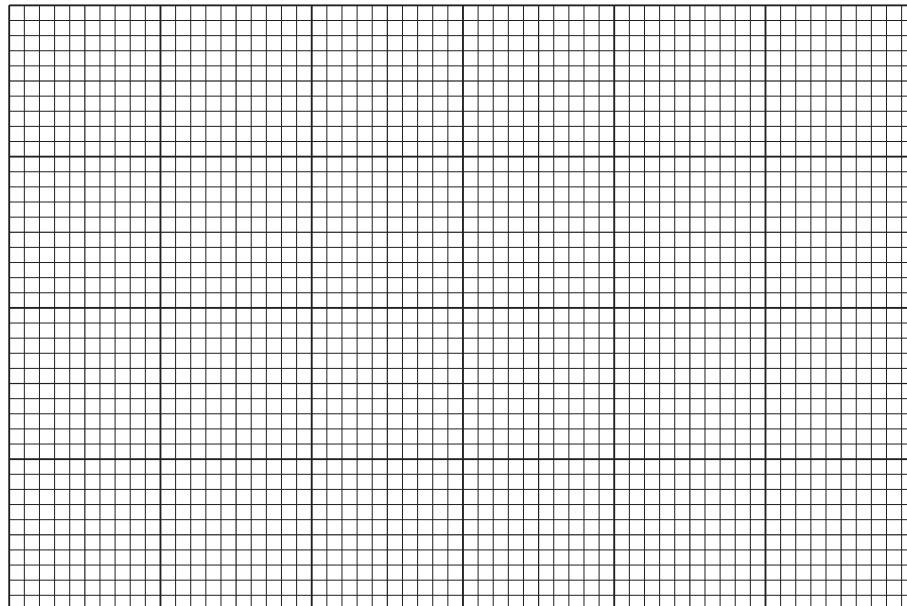


Fig. 2

[3]

(iii) Use your cumulative frequency diagram to find an estimate for the median number of minutes taken to carry out the workshop processes.

..... [1]

(iv) Use your cumulative frequency diagram to find the 60th percentile.

..... [1]

10

(b) Using the table provided, determine the mean and the standard deviation of:

27, 35, 23, 40 and 35.

x	x^2
27	
35	
23	
40	
35	
$\Sigma x =$	$\Sigma x^2 =$

Mean = [1]

Standard deviation =
.....
..... [3]

[Total: 10]

11

5 (a) (i) Velocity v is given by the formula $v = u + at$.

Determine the values of u and a if $v = 60$ when $t = 10$ and $v = 30$ when $t = 4$.

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

[6]

(ii) Calculate the velocity v when $t = 6$.

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

[1]

(b) Solve the quadratic equation $3x^2 + 14x + 8 = 0$.

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

[3]

[Total: 10]

12

6 (a) In a triangle ABC, $AB = 5\text{ m}$, $AC = 8\text{ m}$ and angle $ABC = 42^\circ$. Calculate the angle ACB .

[4]

(b) In another triangle ABC, side $a = 40\text{ mm}$, side $b = 70\text{ mm}$ and angle $C = 50^\circ$. Calculate the length of side c .

[4]

(c) Show that $\sin 30^\circ + \cos 60^\circ + \tan 45^\circ = 2$.

[2]

[2]

[Total: 10]

7 (a) Integrate $\cos 2x + 1/x^2 + \sqrt{x}$ with respect to x.

.....

 [5]

(b) The distance, d metres, travelled by a vehicle in a time interval between t_1 seconds and t_2 seconds is given by:

$$d = \int_{t_1}^{t_2} v(t) dt \text{ where } v(t) \text{ ms}^{-1} \text{ is the vehicle's speed at time } t \text{ seconds.}$$

If $v(t) = 4 + 6t$, calculate the distance travelled by the vehicle 5 seconds after it starts from the rest.

.....

 [3]

(c) The force F newtons acting on a mass at distance s metres from a fixed point is given by $F = 8s - s^2$.

Calculate the work done when the mass is moved from distance s_1 2 metres to a distance s_2 of 6 metres given that:

$$\text{work done} = \int_{s_1}^{s_2} F ds.$$

.....

 [2]

[Total: 10]

8 (a) Explain, using an example, the meaning of the term:

Dependent event.

.....

 [2]

(b) There are 110 brass screws, 120 steel screws and 70 aluminium screws in a container. Three screws are taken randomly from the container without being replaced. Determine the probability that the three screws taken from the container are all steel.

.....

 [4]

(c) Complete the table below. For each pair of events write in the right hand column 'mutually exclusive' or 'not mutually exclusive'.

Event	
When tossing two coins, getting at least one head and getting two tails.	
When choosing a person at random from a football crowd: choosing a female and choosing a female with blonde hair.	
When picking a playing card at random from a pack: getting a diamond and getting a red card.	
When throwing two dice, getting at least one six and getting a total score of 4.	

[4]

[Total: 10]

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