OCR

Thursday 22 May 2014 – Afternoon

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

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H865 01

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 scientific calculator may be used for this paper

SECTION A

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

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

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

2 Factorise the expression $x^2 - 7x + 12$.

.....

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

3 Simplify the expression $(2x - 10)/3 - (4x + 5)/6$.

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

4 Solve the equation $(x + 1)/2 + (x + 2)/3 = (x + 3)/6$.

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

5 A wheel is rotating at the rate of 70 revolutions per minute.

Calculate the angular speed in radians per second.

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

6 An alternating e.m.f. is represented by $v = 50 \sin x$. Calculate the e.m.f. when

(a) $x = 30°$

.....

(b) $x = 270°$

.....

[2]

7 Calculate a value for $\sin^2 x$ and $\cos^2 x$ when $x = 230°$ and then verify that the identity $\sin^2 x + \cos^2 x = 1$ is true when $x = 230°$.

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

8 The sides of a triangle ABC are a = 5 m, b = 8 m and c = 10 m.

Calculate the area of the triangle.

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

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

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

10 Differentiate $y = 4 \ln 2x + 2 e^{5x}$ with respect to x.

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

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

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

12 Calculate the value of the definite integral $\int_2^4 3x^2\,dx$.

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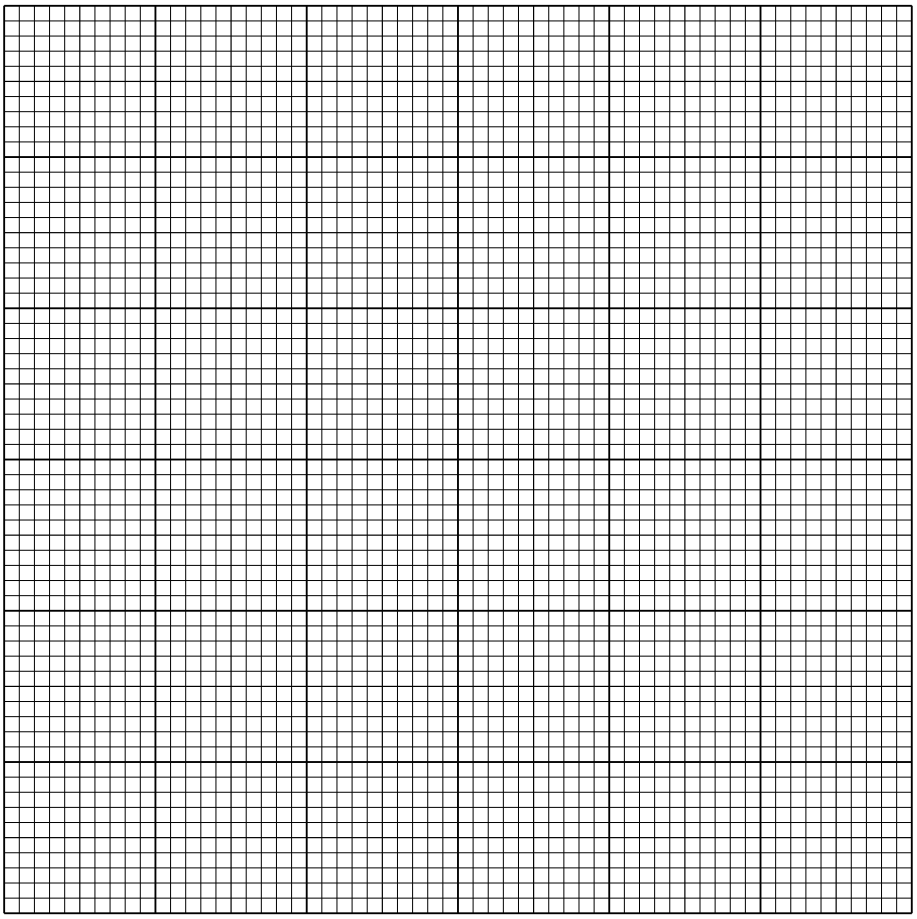
..... **[2]**

13 The table shows the number of days a tourist spent in each of four cities.

Number of days spent in each city	22	12	17	29
Cities	Berlin	London	Paris	Madrid

Draw a labelled bar chart representing this data on the grid below.



[2]

14 A box contains five steel washers and seven brass washers. An engineer picks out a washer from the box at random. The engineer does not put the washer back into the box. The engineer now picks out another washer at random.

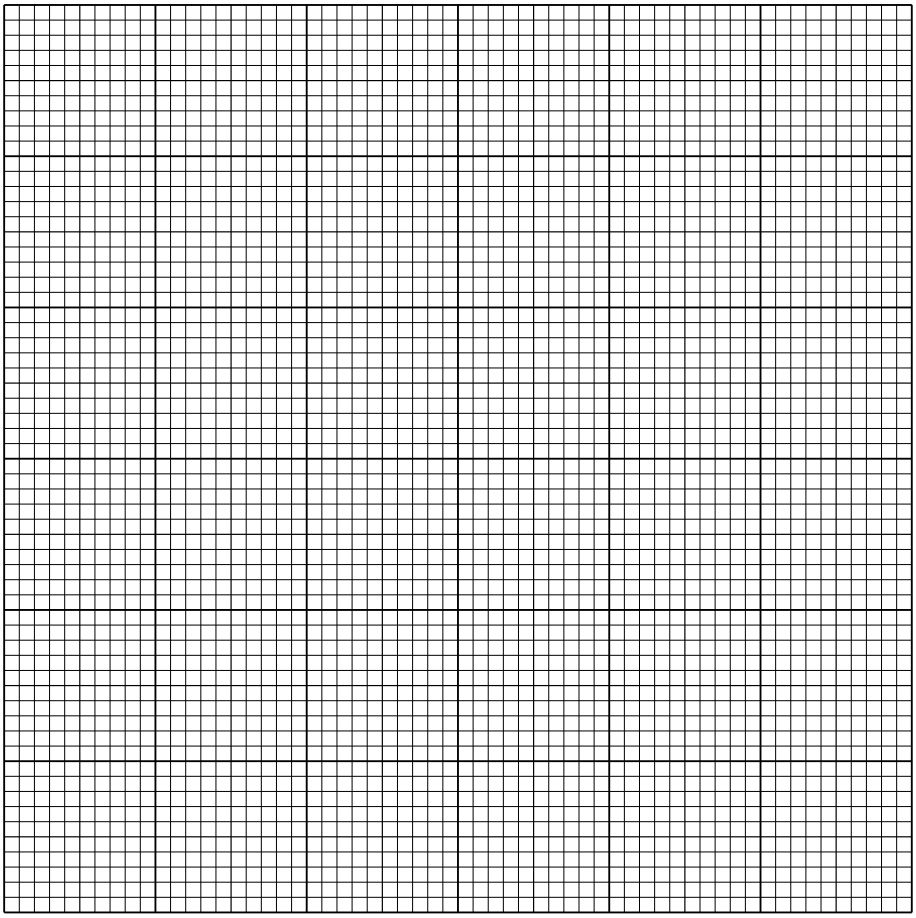
(a) State the probability that the first washer is made from brass.

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

(b) If the first washer was brass, state the probability that the second washer is also brass.

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

15 Draw a distribution curve with a positive skew on the grid below.



[2]

[Total: 30]

SECTION B

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

1 **(a)** Transpose the formula $L_t = L_o (1 + \alpha t)$ to make t the subject.

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

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

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

(c) Transpose the formula $i = nE/(R + nr)$ to make n the subject.

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

[Total: 10]

2 **(a)** A supervisor and five technicians together earn £1750.00 per week.
Six supervisors and nine technicians together earn £5250.00 per week.

Write down two simultaneous equations from the given information.

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

(b) Express $(x – 1)/[(3x – 5)(x – 3)]$ as a sum of two partial fractions.

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..... **[8]**

[Total: 10]

3 **(a)** In a triangle ABC, angle A = 80°, angle B = 30° and side b = 200 mm.

Calculate:

(i) the angle C

.....

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

(ii) the length of side a.

.....

.....

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

(b) In triangle PQR, angle P = 50°, side q = 120 mm and side r = 200 mm.

Calculate:

(i) the length of side p

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

(ii) the angle Q.

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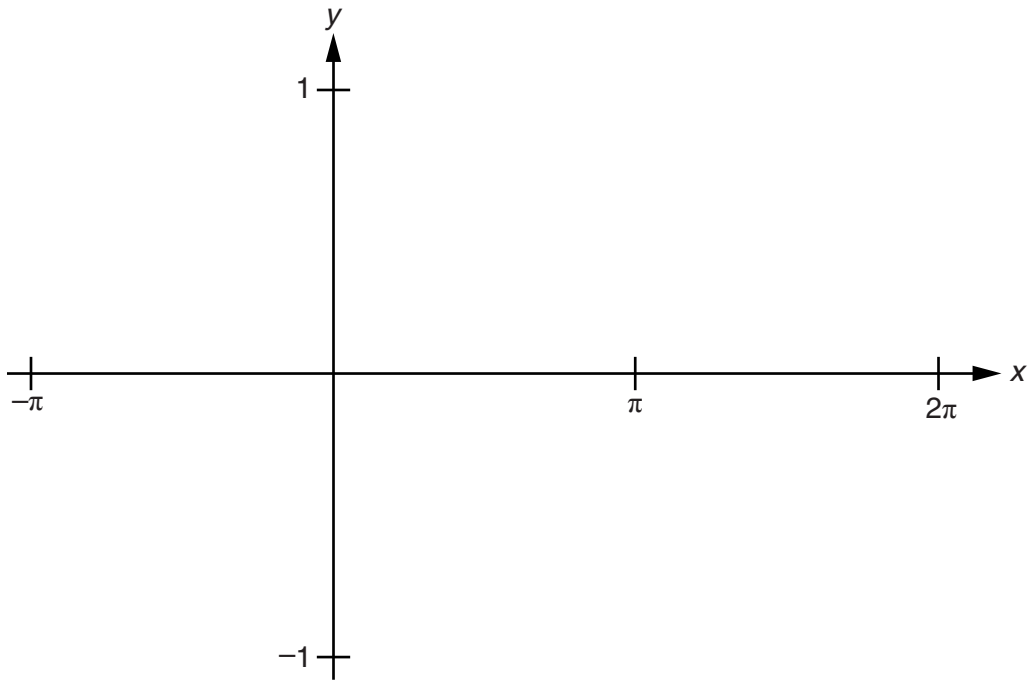
..... **[3]**

[Total: 10]

4 **(a)** Draw and label a graph of $y = \sin x$ and $y = \cos x$ for a range of angles from $-\pi$ to $+2\pi$ on the axes provided.



[4]

(b) Solve the equation 2 cos x = 0.8, giving all the values of x in the interval $0° \geqslant x \geqslant 360°$.

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

(c) Solve the equation 2 cos x = sin x, giving all the values of x in the interval $0° \geqslant x \geqslant 360°$.

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

[Total: 10]

5 A curve is given by the equation $y = x^3 + 1.5x^2 - 18x$.

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

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

(b) Calculate the corresponding values of y.

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

(c) Find the local maximum and minimum turning points.

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

[Total: 10]

6 **(a)** Integrate 4 sin 5x with respect to x.

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

(b) Determine the area enclosed by the curve $y = \cos x$, the ordinates $x = 0$, $x = \pi/2$ and the x-axis.

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

(c) Tests show that the speed, v, of a vehicle braking from $40\,ms^{-1}$ to rest is given by $v = -0.5t^2 - 3t + 40$ where t is the time in seconds after the brakes have been applied.

The distance, s metres, travelled by the vehicle in the interval between t_1 and t_2 seconds is given by

$$s = \int_{t_1}^{t_2} v\,dt$$

Calculate the distance travelled between 3 and 6 seconds.

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

[Total: 10]

7 **(a)** For the given set of values shown below

12 14 14 16 18 18 20

Determine:

(i) the range .....

(ii) the median .....

(iii) the lower and upper quartile .....

(iv) the interquartile range .....

[4]

(b) The sample values 78, 92, 102 and 72 are taken from a population.

(i) Calculate the mean value $\bar{x}$ of the sample.

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

(ii) Complete the table provided using your answer from **(b)(i)**.

Value x	$x - \bar{x}$	$(x - \bar{x})^2$
78		
92		
102		
72		
		$\Sigma =$

[3]

(iii) Calculate the standard deviation of the sample using the information from the completed table above.

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

[Total: 10]

8 **(a)** Give the meaning of the term probability.

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

(b) Explain what is meant by the term independent events.

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

(c) Explain what is meant by the term mutually exclusive events.

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

(d) If two events x and y are independent state a formula for the probability P of them both occurring.

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

(e) If two events x and y are mutually exclusive state a formula for the probability P that either one event or the other will occur.

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

(f) A manufacturer has made 40 components and painted them different colours.

8 components are red.
14 components are white.
18 components are blue.

All the components are placed in a container.

State the probability that a component taken from the container at random without looking into the container

(i) will be white

.....

(ii) will be blue or red

.....

(iii) will not be red

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[3]

[Total: 10]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE