

Thursday 24 May 2012 – 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



Candidate forename		Candidate surname	
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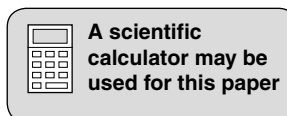
Centre number						Candidate number				
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INSTRUCTIONS TO CANDIDATES

- 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.



Section A

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

- 1 Remove the brackets and simplify $-5(ab - cd)$.

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

- 2 Factorise the expression $abc - ade$.

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

- 3 Given the formula $Mv + mu = MV + mU$ find M in terms of the other quantities.

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

- 4 Solve the equation $3(x + 2) = 6x + 12$.

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

- 5 Resolve the expression, $5/(x^2 + x - 6)$, into its partial fractions.

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

- 6 Convert, correct to 2 decimal places, 128° to radians.

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

7 Verify that $\sin 30^\circ + \cos 60^\circ + \tan 45^\circ = 2$.

.....

 [2]

8 Calculate, correct to 2 dp, the area of a triangle ABC given that $b = 6$ m, $c = 10$ m, and $A = 70^\circ$.

.....

 [2]

9 Find the gradient of the curve $y = 2x^5 + 3x^4$ when $x = 2$.

.....

 [2]

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

.....

 [2]

11 Integrate \sqrt{t} with respect to t .

.....

 [2]

12 Calculate the value of the definite integral $\int_4^5 8x \, dx$.

.....

 [2]

- 13 One thousand candidates take an examination in which they are asked to answer one out of four questions.

Draw, on the axes provided in Fig. 1, a bar chart from the given table of data.

Question number	1	2	3	4
Number of attempts	100	200	300	400

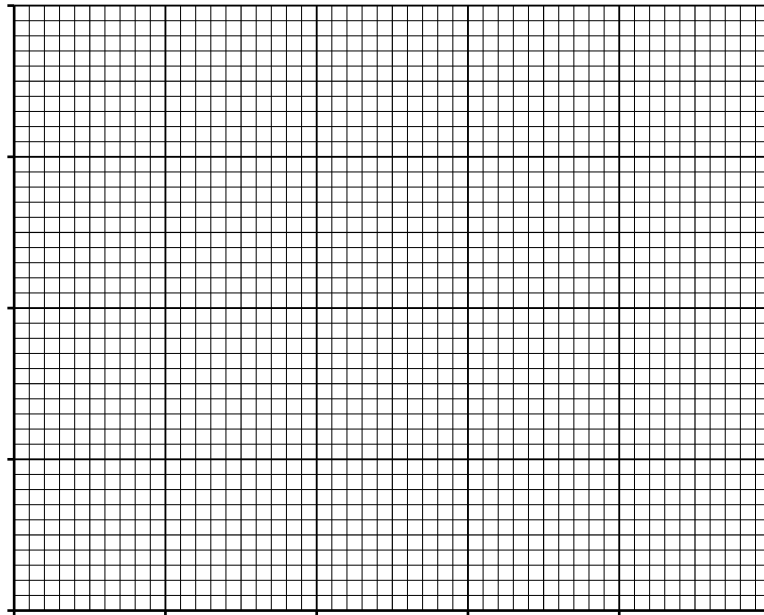


Fig. 1

[2]

- 14 Determine the mode and median for the set of given values:

8, 11, 9, 13, 10, 12, and 8

Mode [1]

Median [1]

- 15 A box contains 5 steel screws, 6 brass screws and 9 aluminium screws. An electrician chooses a screw at random.

State the probability that the electrician chooses:

- (i) a steel screw or a brass screw

.....

- (ii) a brass screw or an aluminium screw.

..... [2]

[Total for Part A: 30]

Section B

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

Correct all answers to two decimal places except where otherwise stated.

- 1 (a) The volume of a cone is given by the formula $V = (\pi R^2 h)/3$.

Calculate the volume of the cone when $R = 10\text{m}$ and $h = 30\text{m}$.

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

- (b) (i) Transpose the formula $V = (\pi R^2 h)/3$ to make R the subject.

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

- (ii) Calculate the value of R when the volume V is 100m^3 and $h = 25\text{m}$.

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

- (c) The diameter of a sphere is given by $D = \sqrt[3]{(6V/\pi)}$.

Transpose the formula to make V the subject.

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

[Total: 10]

2 (a) The resistance $R\Omega$ of a length of wire at temperature $t^\circ\text{C}$ is given by $R = R_0 (1 + \alpha t)$, where R_0 is the resistance at 0°C and α is the temperature coefficient of resistance.

when: $R = 40\Omega$ at 60°C and $R = 20\Omega$ at 100°C .

(i) Determine:

the value of the temperature coefficient α as a fraction.

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

(ii) the value of the resistance R_0 when $R = 40\Omega$ at 60°C and $R = 20\Omega$ at 100°C .

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

(b) The reactance of a circuit is given by $X = \sqrt{Z^2 - R^2}$.

Find the resistance R in terms of impedance Z and reactance X .

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

[Total: 10]

- 3 (a) A triangle ABC has angle $A = 70^\circ$, angle $C = 42^\circ$ and side $b = 150$ mm.

Calculate:

- (i) angle B

.....

 [1]

- (ii) the length of side c.

.....

 [3]

- (b) A ship sails from a point H and travels 25 km on a bearing of 30° before reaching a point B. At this point the ship turns and follows a course on a bearing of 90° and travels for 32 km until it reaches point I. On the return journey, the ship is able to take the most direct route back to point H.

(Bearings are measured clockwise from north)

- (i) Draw a diagram to represent both the outward and return journeys.

[2]

- (ii) Calculate the total distance travelled by the ship.

.....

 [4]

[Total: 10]

4 (a) Verify the identity $\sin^2 x + \cos^2 x = 1$ in the case when $x = 60^\circ$.

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

(b) Prove that $\tan A = \sec A / \operatorname{cosec} A$.

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

(c) A chord of a circle of radius 200 mm subtends an angle of 50° at the centre.

Calculate the length of the minor (shorter) arc and major (longer) arc.

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

[Total: 10]

- 6 (a) The instantaneous value of a sinusoidal current is given by the formula $i = 20 \sin \theta$ amperes.

Determine the mean value of the current over half a cycle where the mean value over the integral a to b is given by the formula:

$$\text{mean value} = \frac{1}{(b - a)} \int_a^b i \, d\theta$$

.....

.....

.....

.....

..... [3]

- (b) The pressure P and volume V of a liquid are related by the formula $PV^2 = \text{constant}$.

- (i) Calculate a value for the constant if $P = 250 \text{ Nm}^{-2}$ when $V = 0.3 \text{ m}^3$.

.....

..... [1]

- (ii) Transpose the formula to make P the subject.

..... [1]

- (iii) Calculate the work done in expanding the liquid from the volume of 0.3 m^3 to 0.45 m^3 given that

$$\text{work done} = \int_{0.3}^{0.45} P \, dV$$

.....

.....

.....

.....

.....

..... [5]

[Total: 10]

7 (a) Over a one-year period a garage repaired 980 cars, of which 75% ran on unleaded fuel.

The cars have either a small engine or a large engine.

200 of these cars have a large engine. 80% of these ran on unleaded fuel.

Complete the table with the number of cars in each fuel category.

Type of fuel	Large engine	Small engine	Total
Unleaded			
Other			
Total			980

[4]

(b) From the data in the table, calculate the probability that a repair chosen at random is a car:

(i) with a small engine running on the other type of fuel
 [1]

(ii) with a small engine running on unleaded fuel
 [1]

(iii) with a large engine running on the other type of fuel
 [1]

(iv) with a large engine running on unleaded fuel
 [1]

(v) that **either** runs on unleaded fuel **or** has a small engine.
 [2]

[Total: 10]

8 The table shows the distribution of the ages of engineers in a workshop.

Age in years	< 20	< 25	< 30	< 35	< 50
Cumulative frequency	12	30	40	48	50

(a) Draw, on the axes provided in Fig. 2, a cumulative frequency curve.

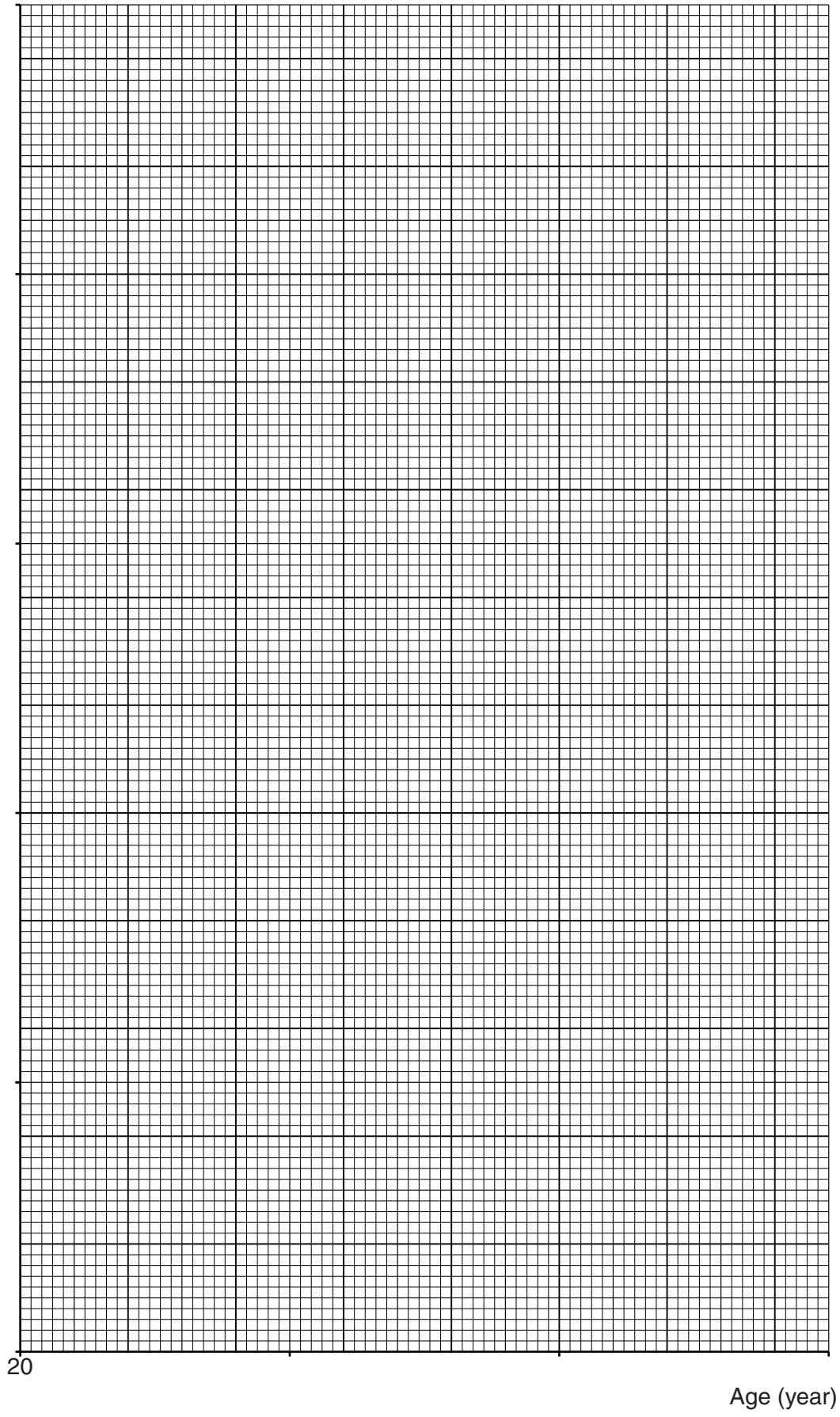


Fig. 2

[3]

Use the graph to:

- (b) (i)** estimate how many engineers in the workshop are less than 27 years old
..... [1]
- (ii)** estimate how many engineers in the workshop are at least 37 years old
..... [1]
- (iii)** determine the median age
..... [1]
- (iv)** determine the lower quartile age
..... [1]
- (v)** determine the upper quartile age
..... [1]
- (vi)** determine the inter-quartile range.
..... [2]

[Total: 10]

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