Write your name here

Surname	Other names

Edexcel
Principal Learning

Centre Number	Candidate Number

Engineering

Level 3
Unit 8: Mathematical Techniques and Applications for Engineers

Thursday 10 June 2010 – Morning
Time: 1 hour 15 minutes

Paper Reference
EG308/01

Calculators may be used.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 60.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

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H 3 5 8 0 9 A 0 1 1 6

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Laws of indices

$$a^m \times a^n = a^{m+n}$$

$$\frac{a^m}{a^n} = a^{m-n}$$

$$\left(a^m\right)^n = a^{mn}$$

Laws of logarithms

$$\log\ a + \log\ b = \log\ ab$$

$$\log\ a - \log\ b = \log\ \frac{a}{b}$$

$$\log\ a^n = n \log\ a$$

Quadratic formula

$$x = \frac{-\ b \pm \sqrt{b^2 - 4ac}}{2a}$$

Mensuration

	Volume	Surface area
Cylinder	$\pi r^2 h$	$2\pi rh + 2\pi r^2$
Sphere	$\frac{4}{3}\pi r^3$	$4\pi r^2$
Cone	$\frac{1}{3}\pi r^2 h$	$\pi r \times$ slant height

Circular measure and trigonometry

$$s = r\theta$$

$$A = \frac{1}{2} r^2 \theta$$

$$\tan A = \frac{\sin A}{\cos A}$$

Sine rule $\quad \dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C}$

Cosine rule $\quad a^2 = b^2 + c^2 - 2bc \cos A$

Calculus

Differentiation

y	$\dfrac{\mathrm{d}y}{\mathrm{d}x}$
x^n	nx^{n-1}
$a \sin kx$	$ka \cos kx$
$a \cos kx$	$-ka \sin kx$
ae^{kx}	kae^{kx}

Integration

y	$\int y \, \mathrm{d}x$
x^n	$\dfrac{x^{n+1}}{n+1}$ $\quad (n \neq -1)$
$a \sin kx$	$-\dfrac{a}{k} \cos kx$
$a \cos kx$	$\dfrac{a}{k} \sin kx$
ae^{kx}	$\dfrac{a}{k} e^{kx}$

Turn over ▶

Answer ALL questions. Write your answers in the spaces provided.
You must write down all stages in your working.

1 (a) Given that $v = \frac{4}{3}\pi r^3$,

(i) make r the subject of the equation

(3)

(ii) find r when $v = 2000$

(1)

(b) Using the laws of logs, determine the value of x from the equation:

$$\log\left(\frac{24}{6}\right)+\log 8 = 5\log x$$

(3)

(c) The gain of an amplifier, G, is given by the equation $G = 10\log_{10}\frac{P_{out}}{P_{in}}$ dB.

Find the value of output power P_{out} when the input power P_{in} = 250 mW and G = 20dB

(3)

(Total for Question 1 = 10 marks)

2 (a) The effort required to raise a load is shown in Table 1.

(i) Use the data in Table 1 to complete Figure 1 and determine the equation of the line.

(ii) Calculate the effort when the load is zero.

(iii) Calculate the effort when the load is 4000N.

(4)

Load (W)	Effort (E)
1000	46
1500	66
2000	86
2500	106

Table 1

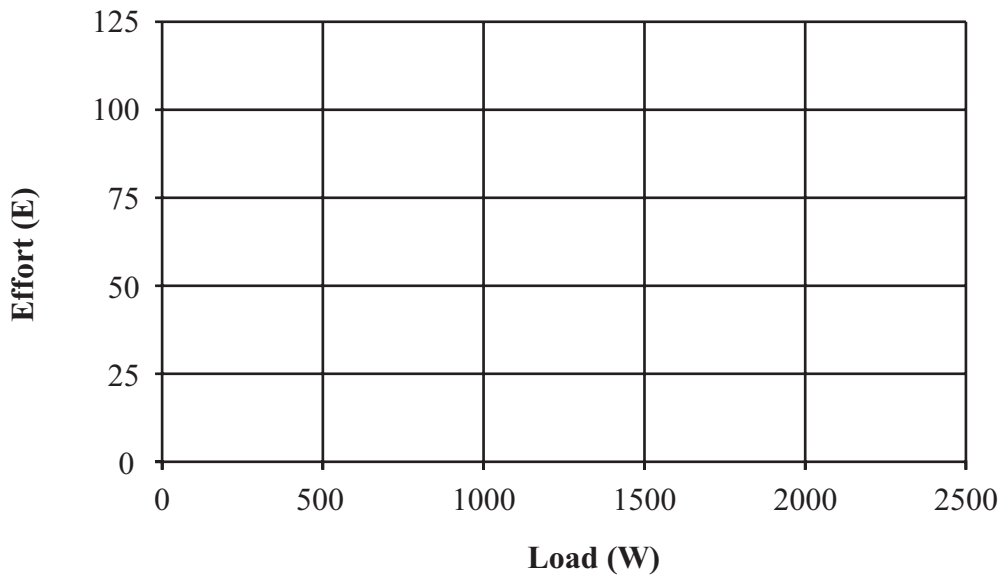


Figure 1

(b) The area of a component is given by the formula: $\frac{\pi d^2}{4} + d^2$

Factorise the formula.

(2)

(c) An open rectangular storage tank has top surface dimensions of x metres and $(x + 7)$ metres.

The top surface area is to be 30m^2

Calculate the value of x required.

(4)

(Total for Question 2 = 10 marks)

3 (a) A ramp is to be designed as shown in Figure 2. Calculate the distance x.

(3)

All dimensions in metres

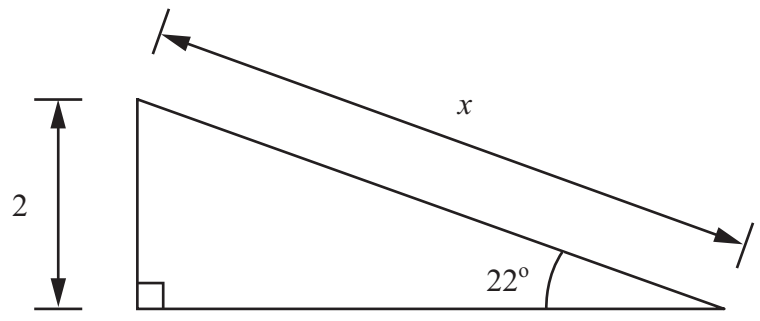


Figure 2

(b) A current is given by the equation $i = 2 + 2\cos\theta$ amps.

Sketch on Figure 3 one cycle of the equation and from it determine the value of i when $\theta = 180°$

(3)

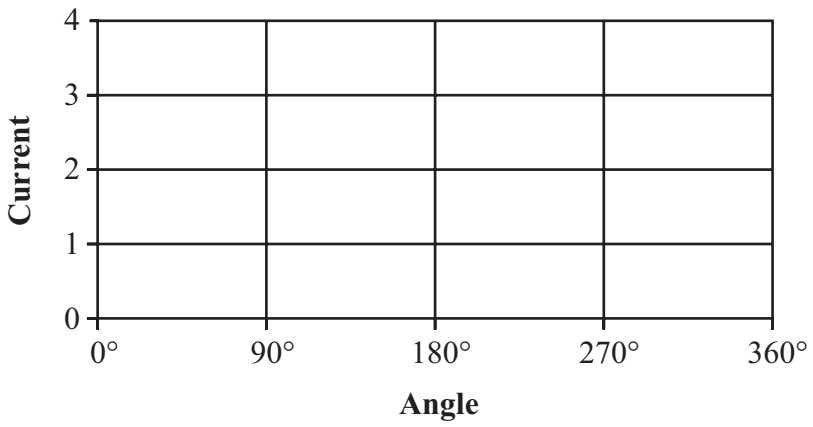


Figure 3

(c) In Figure 4, a and b are two vectors which represent forces.

Given that $a = 60\text{N}$ and $b = 65\text{N}$, calculate the magnitude of the resultant force c.

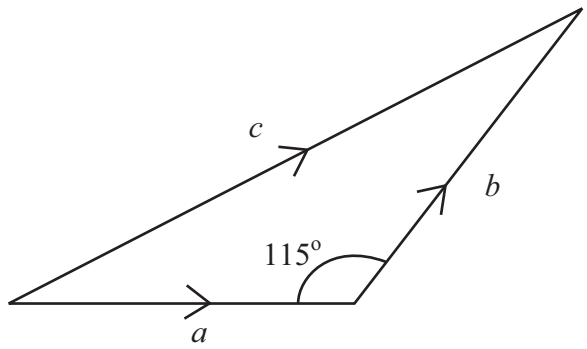


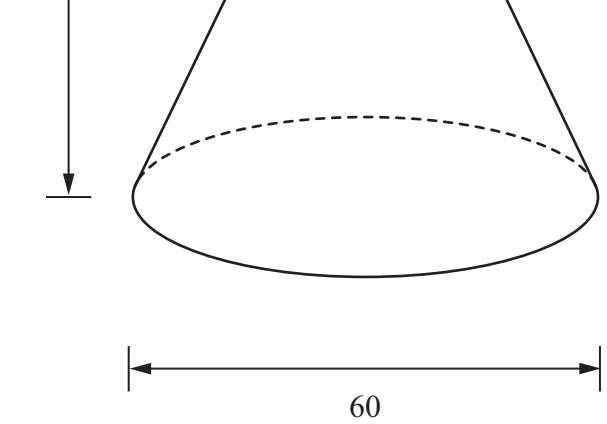
Figure 4

(4)

(Total for Question 3 = 10 marks)

4 (a) Calculate the volume and surface area of the open-ended cone shown in Figure 5.

(5)



All dimensions in millimetres

Figure 5

(b) A telecommunications satellite moves through an angle of 1.2 radians across the sky.

Calculate this angle to the nearest degree.

(2)

(c) An internal combustion engine rotates at 750 rpm.

Calculate this speed in radians per second.

(3)

(Total for Question 4 = 10 marks)

5 The mean times to failure (MTTF) of nine engineering processes are given in Figure 6.

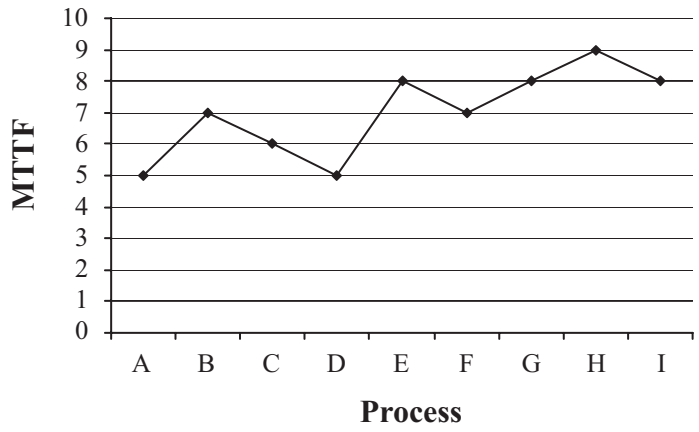


Figure 6

(a) State the mode value.

(1)

(b) Calculate the median value.
You must show your working.

(2)

(c) Calculate the mean value.
You must show your working.

(3)

(d) State conclusions you can make from the data about the processes.

(2)

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(Total for Question 5 = 8 marks)

6 (a) Figure 7 shows the change in current in an electrical circuit as the resistance increases.

Sketch a tangent to the curve and use it to calculate the rate of change of current, with respect to resistance, at $R = 20\Omega$.

(4)

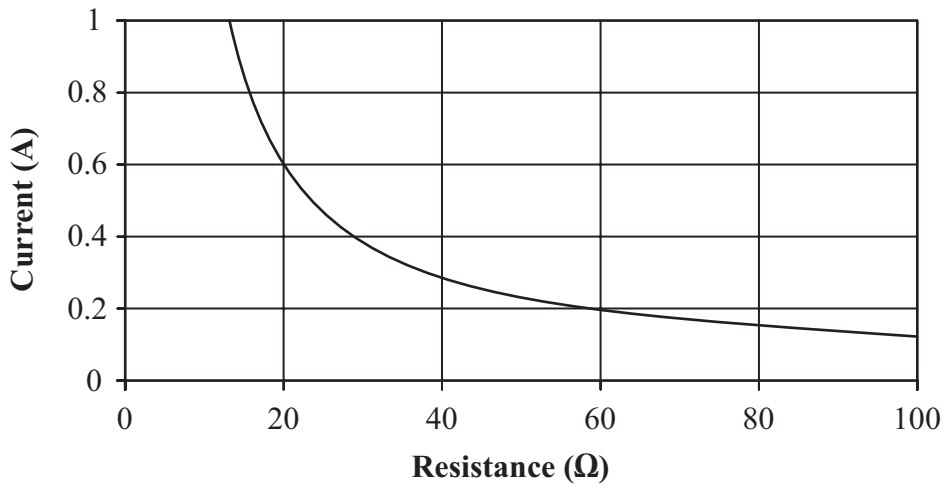

Figure 7

(b) A vehicle is moving at a velocity, v , given by $v = 12t - 3t^2$ ms^{-1}.

Use calculus to produce an equation for the acceleration of the vehicle and find the value of acceleration at $t = 3$

State an observation you can make about the acceleration.

(4)

(c) Use calculus to produce an equation for the distance travelled by the vehicle and find the distance travelled by the vehicle in the time $t = 0$ to $t = 3$

(4)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

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