Write your name here

Surname	Other names

Pearson Edexcel Principal Learning

Centre Number	Candidate Number

Engineering

Level 3
Unit 8: Mathematical Techniques and Applications for Engineers

Wednesday 3 June 2015 – Afternoon
Time: 1 hour 15 minutes

Paper Reference
EG308/01

You must have:
Calculator

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.

Turn over ▶

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P 4 5 0 2 5 R A 0 1 1 6

PEARSON

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 $$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

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

Calculus

Differentiation

y	$\frac{dy}{dx}$
x^n	nx^{n-1}
$a \sin kx$	$ka \cos kx$
$a \cos kx$	$-ka \sin kx$
ae^{kx}	kae^{kx}

Integration

y	$\int y\,dx$
x^n	$\frac{x^{n+1}}{n+1}$ $(n \neq -1)$
$a \sin kx$	$-\frac{a}{k} \cos kx$
$a \cos kx$	$\frac{a}{k} \sin kx$
ae^{kx}	$\frac{a}{k} e^{kx}$

Answer ALL questions. Write your answers in the spaces provided.

You must write down all stages in your working.

1 (a) Given that $v = \frac{1}{3}\pi r^2 h$

(3)

Make r the subject of the expression.

(b) Simplify the expression

$$\frac{a^3}{a^{-2}}$$

(1)

(c) Given that $\log 12 - \log x = \log 3 + \log 2$, use the laws of logarithms to determine the value of x.

(3)

(d) A component in a circuit was monitored and showed that the temperature during cooling could be found from

$$\theta = \theta_1 e^{\frac{-k}{t}}$$

Find the value of the constant k when $\theta_1 = 50°C$, $\theta = 20°C$ and $t = 45$ seconds.

(3)

(Total for Question 1 = 10 marks)

2 (a) A racing car moving on a track accelerates and the increase in velocity over a time period is recorded. This is shown in Table 1 below.

Velocity (ms^{-1})	10	17	25	32	39	46	54	60
Time (s)	0	2	4	6	8	10	12	14

Table 1

(i) Use the data to plot a line of best fit on Figure 1.

(1)

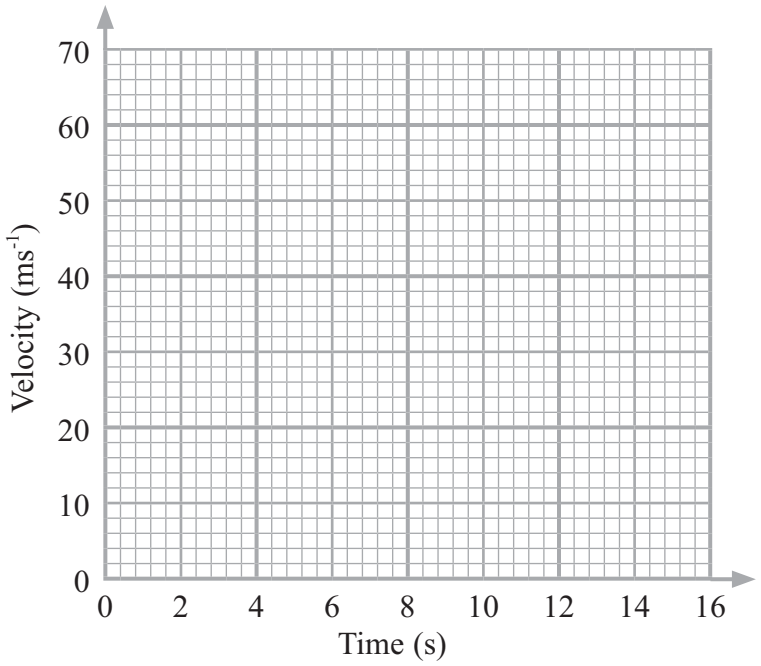

Figure 1 – Velocity-time graph

(ii) Determine the equation of the straight line.

(3)

(b) Solve the following equation by factorisation.

$6t^2 - 5t + 6$

(3)

(c) The number of components (x), produced by a machine can be determined from the relationship

$x = 6t^2 + 10.5t$

Where t = the time in seconds.

Determine the value of t when $x = 3$

(3)

(Total for Question 2 = 10 marks)

3 (a) A steel tie rope supports a beam, as shown in Figure 2. Determine the length, x, of the steel tie rope.

(3)

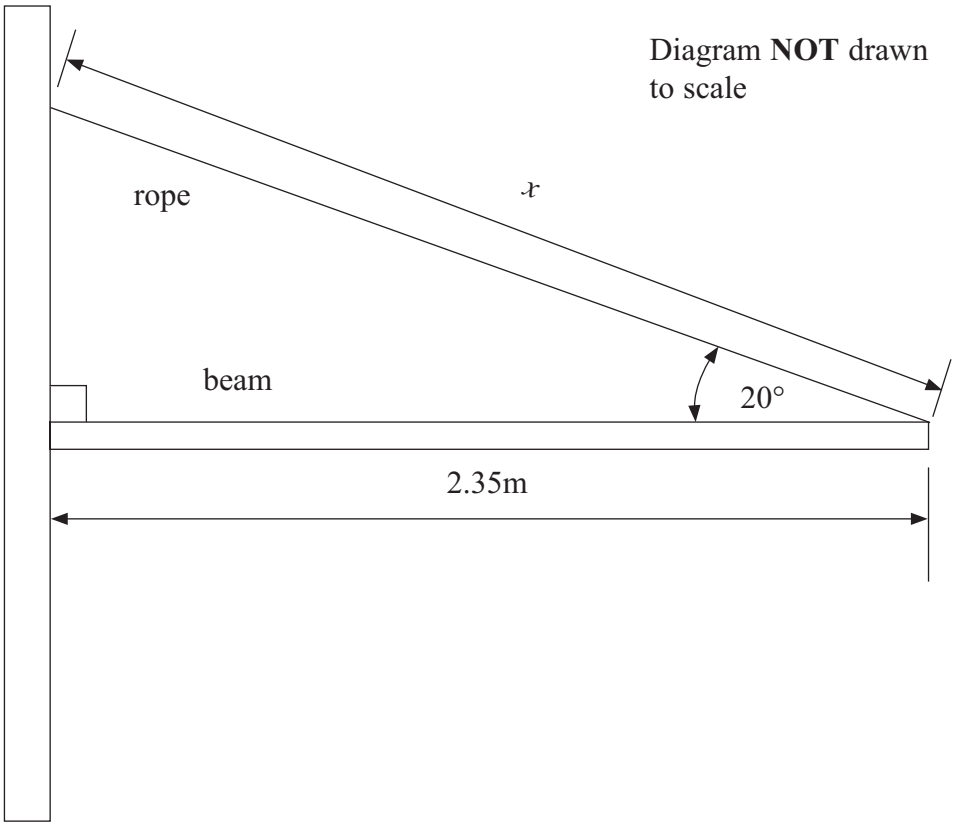

Figure 2

(b) A plate is cut to the shape shown in Figure 3. Determine the angle *A*.

(4)

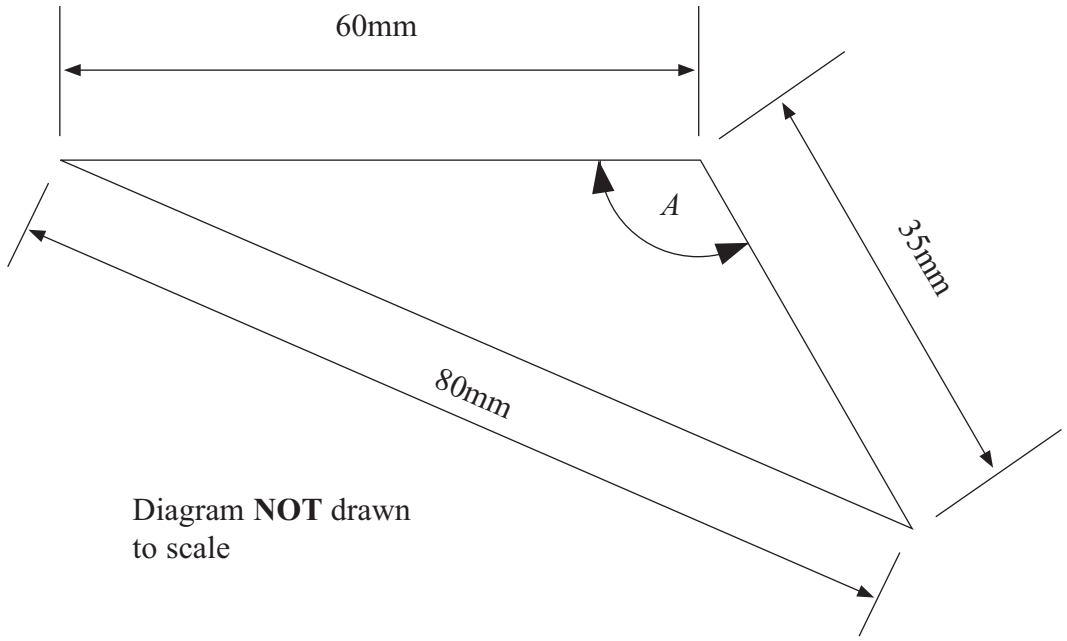

Figure 3

(Total for Question 3 = 7 marks)

4 (a) Figure 4 shows an engineering component used in a vehicle winch. The component is produced from a solid bar 25mm diameter and 70mm long, with a machined square hole of size 10mm x 10mm throughout the length.

Determine the volume of the component.

(3)

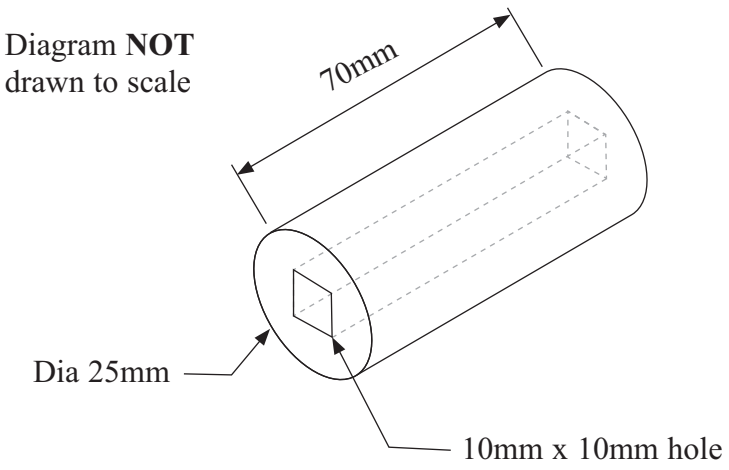

Figure 4

(b) The winch has a drum of radius 120mm. The drum rotates through 240 degrees to release the rope. What is the length of rope unwound from the drum?

(2)

(c) In operation, the winch rotates at a speed of 25 revolutions per minute. Calculate the angular velocity of the winch in radians per second.

(2)

(d) A plate attached to the winch drum is shown in Figure 5.

Determine the area of the plate.

(3)

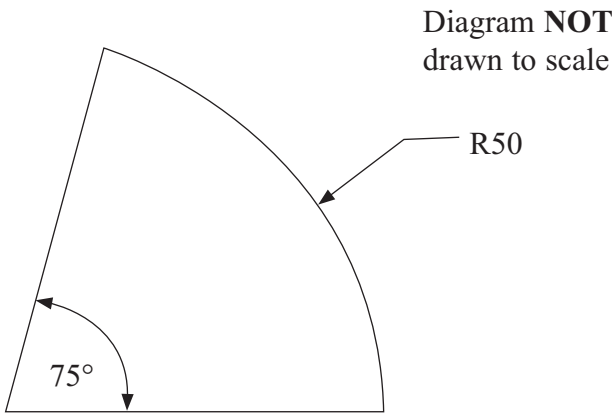

Figure 5

(Total for Question 4 = 10 marks)

5 A new electrical product has a pre-production trial run. The data for the power ratings has been recorded and shown as a grouped frequency distribution in Table 2.

Power (watts)	Frequency	Cumulative Frequency
386-390	1	
391-395	4	
396-400	7	
401-405	14	
406-410	23	
411-415	26	
416-420	17	
421-425	5	
426-430	1	

Table 2

(a) Complete the table to show the cumulative frequency for the product.

(1)

(b) In statistics, what is meant by the term mode?

(1)

(c) Which group of power ratings represents the mode for the trial run?

(1)

(d) (i) Use the values from Table 2 to draw a cumulative frequency curve on Figure 6.

(2)

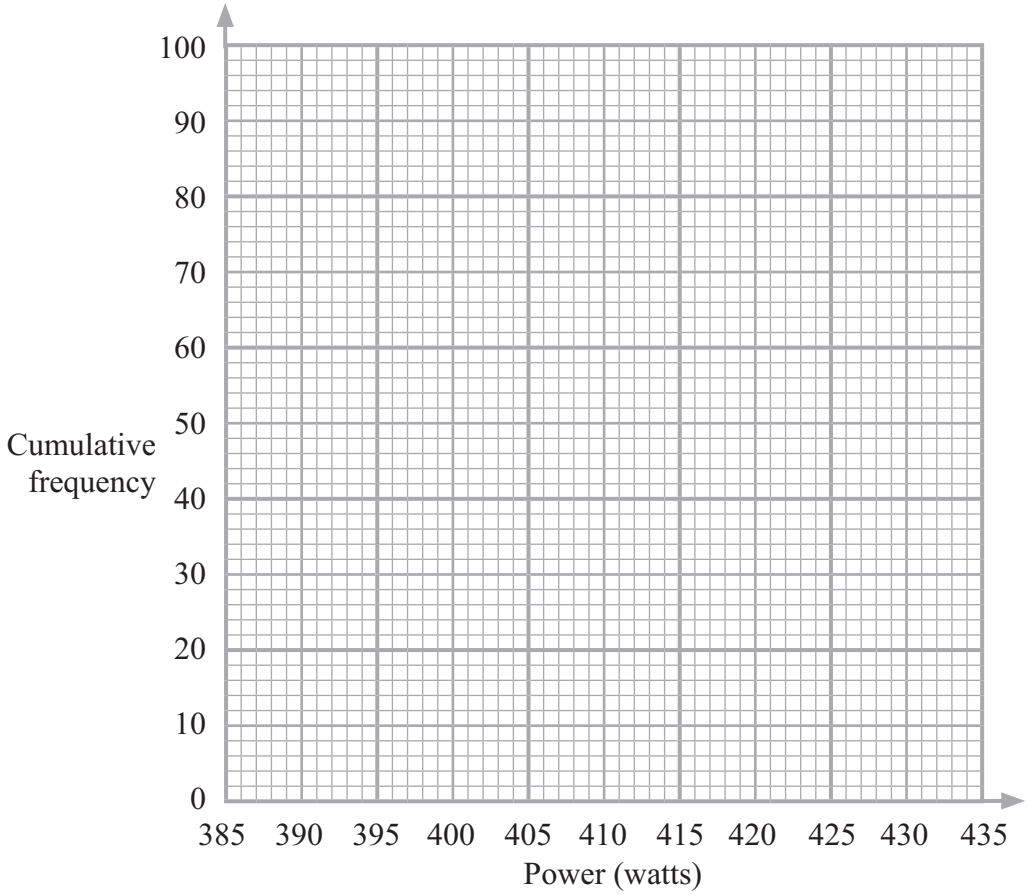

Figure 6

(ii) Determine the median value for the power from the cumulative frequency curve.

(2)

(e) Calculate the mean value for the power.

(3)

(Total for Question 5 = 10 marks)

6 The distance travelled by an aircraft, increasing over a time period, was monitored and recorded on a graph. Figure 7 shows the results.

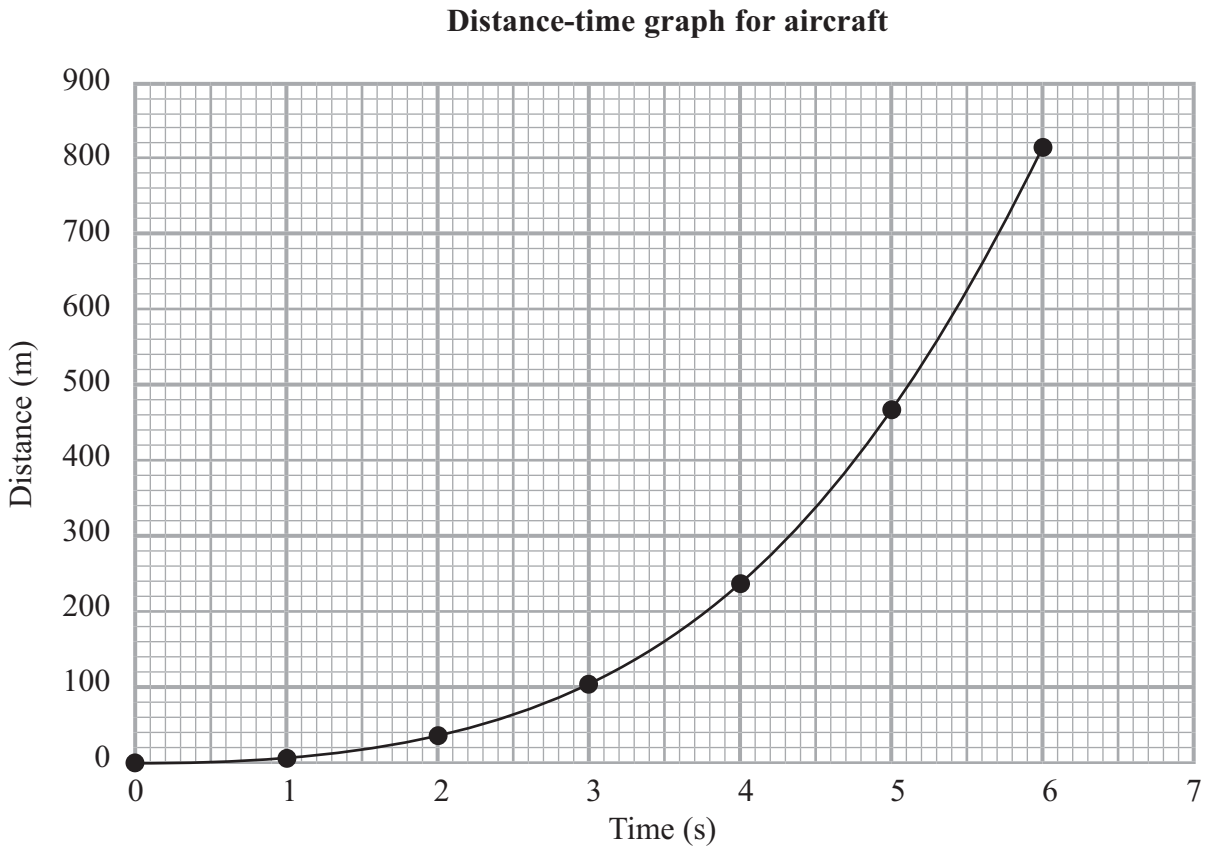

Figure 7

(a) Draw on Figure 7 a tangent at $t = 4$ s and use it to determine the rate of change of distance at this point.

(4)

(b) The velocity of the aircraft can be determined by the expression

$v = 12t^2 - 4t + 3$

Differentiate the expression and use this to determine the acceleration of the aircraft at $t = 5$ s

(4)

(c) Integrate the expression $v = 12t^2 - 4t + 3$ and use this to determine the distance travelled between $t = 2$ and $t = 5$

(5)

(Total for Question 6 = 13 marks)

TOTAL FOR PAPER = 60 MARKS

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