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

Tuesday 19 January 2010 – Afternoon
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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5/5/4/2

H 3 5 9 8 7 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 $A = \frac{1}{2}r^2\theta$,

(i) make r the subject of the equation,

(3)

(ii) find r when $A = 50$ and $\theta = 0.6$

(1)

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

$\log 48 - \log x = 3\log 2$

(3)

(c) The voltage, v, in a circuit is given by the equation $v = 20(1 - e^{-\frac{t}{\tau}})$V.

Given $\tau = 5$, calculate the time, t, at which the voltage has risen to 12V.

(3)

(Total for Question 1 = 10 marks)

2 (a) The velocity of an object for given values of time are shown in Table 1.

(i) Use the data in Table 1 to complete Figure 1

(1)

(ii) Determine the equation of the best fit straight line.

(1)

(iii) Calculate the initial velocity and the velocity after 40 seconds.

(2)

Time t (s)	Velocity v (ms^{-1})
10	85
15	95
20	105
25	115

Table 1

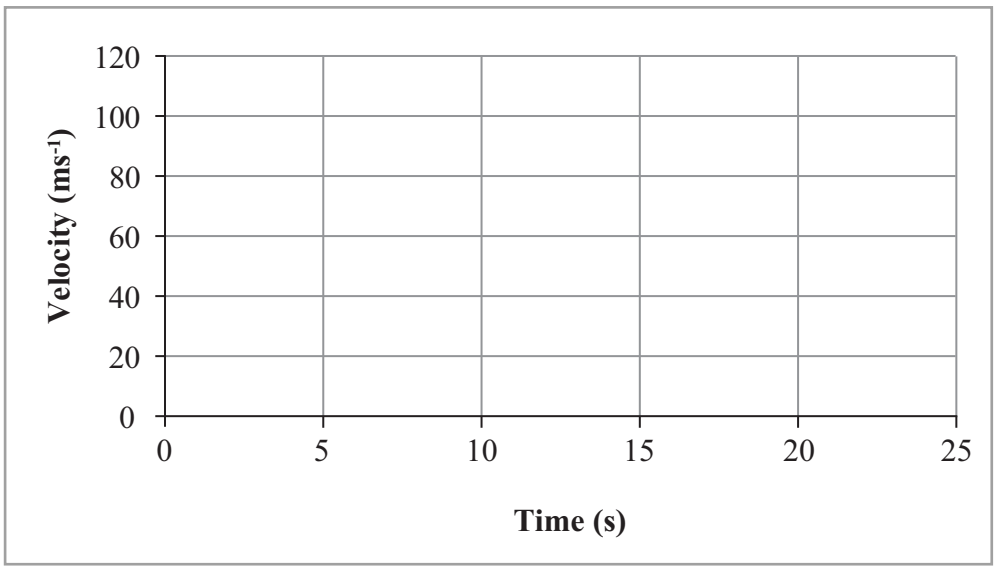


Figure 1

(b) A closed cylindrical storage tank has a surface area given by the formula:

$2\pi r^2 + 2\pi rh$

Factorise the formula.

(2)

(c) The distance, d, travelled by an object from a fixed point after time t, is given by:

$d = 2t^2 + 5t - 12$

(i) Determine the two values of t such that $d = 0$

(3)

(ii) Using your answers, explain how you identified the actual value for d.

(1)

.....

.....

(Total for Question 2 = 10 marks)

3 (a) A current is given by the equation $i = 1.5 + \sin\theta$ amps.

Sketch, on Figure 2, one cycle of the current and from this sketch determine the value of i when $\theta = 270°$.

(3)

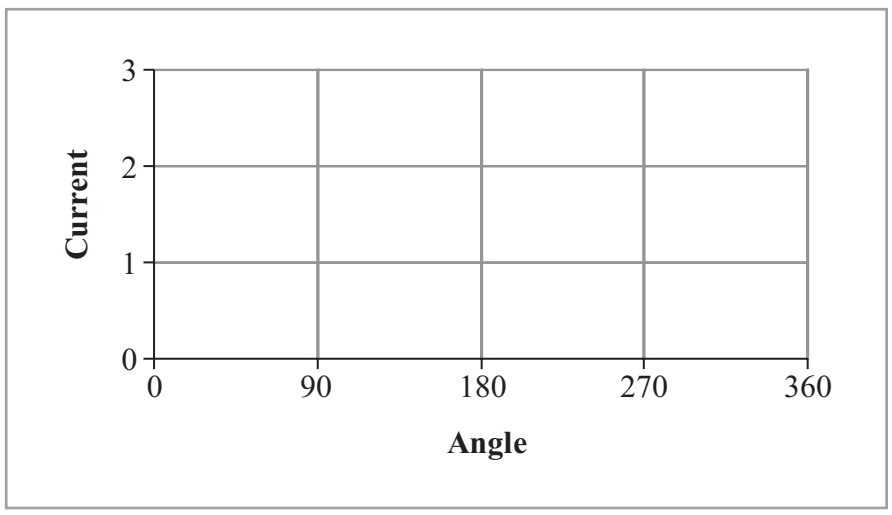
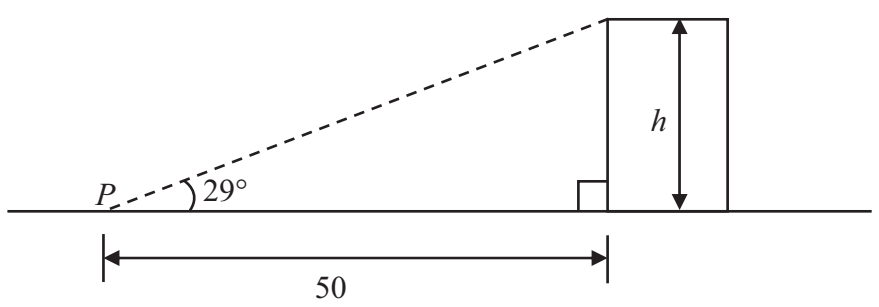


Figure 2

(b) A theodolyte is used to measure the angle from a known fixed point, P, to the top of a building, as shown in Figure 3.

Calculate the height, h, of the building.

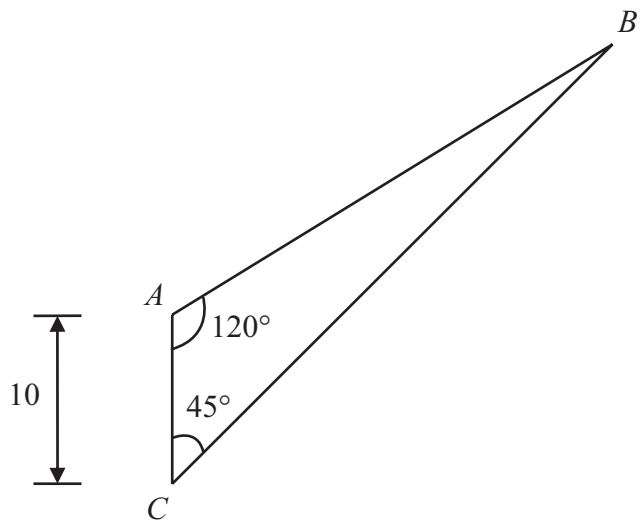
(3)



All dimensions in metres

Figure 3

(c) A jib crane is shown in Figure 4.



All dimensions in metres

Figure 4

Calculate the length of the tie *AB*.

(4)

(Total for Question 3 = 10 marks)

4 (a) Calculate the volume and surface area of a ball bearing with a diameter of 30 mm.

(4)

(b) A test vehicle is driven 150 m round a circular track of radius 35 m.

Calculate the angle through which the vehicle travels.

(3)

(c) A shaft is rotating at 80 radians per second.

Calculate this angular velocity in rpm.

(3)

(Total for Question 4 = 10 marks)

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5 The failure rates of 9 components in an electronic circuit are given in Table 2.

Component identification	R1	R2	R3	R4	C1	C2	C3	T1	T2
Failure rate per thousand	6	9	7	2	5	12	7	11	4

Table 2

(a) Define the term ‘mode’ and give its value for this data.

(2)

.....

.....

.....

.....

(b) Define the term ‘median’ and give its value for this data.

(3)

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.....

.....

.....

(c) Calculate the mean value.

You must show your working.

(3)

(Total for Question 5 = 8 marks)

6 (a) Figure 5 shows the velocity, v, of an object after it has been launched.

Sketch a tangent to the curve at time $t = 1$s and use it to obtain the rate of change of velocity at $t = 1$s.

(3)

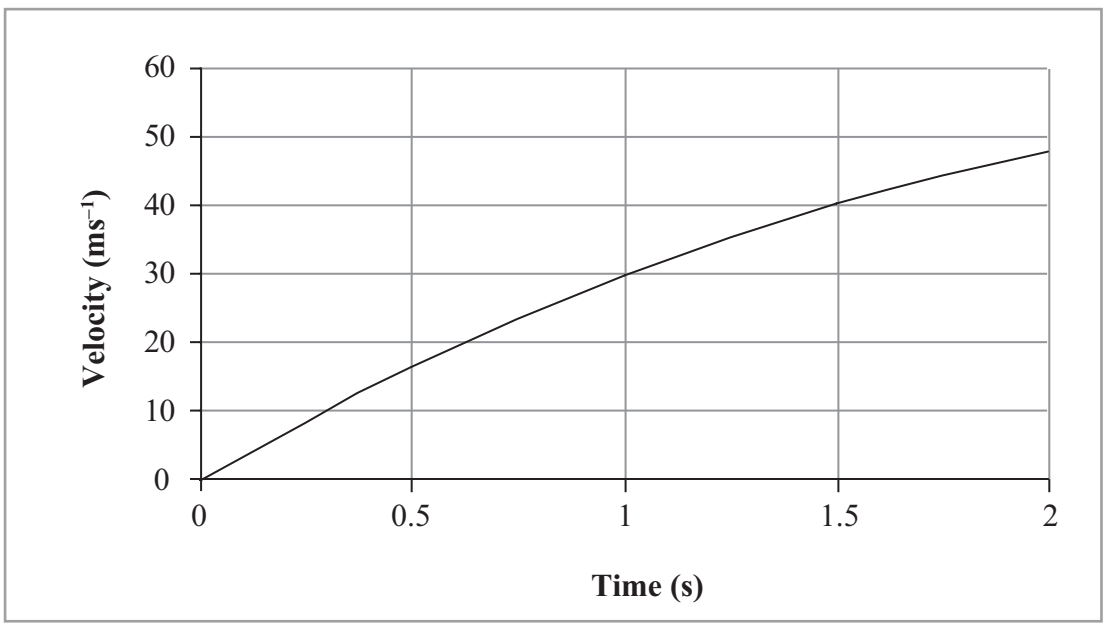

Figure 5

(b) The equation of the velocity is found to be $v = 36t - 6t^2$

Use differentiation to find:

(i) the time at which the maximum velocity occurs,

(4)

(ii) the maximum velocity.

(1)

(c) Use integration to find the distance travelled by the vehicle in the time $t = 0$ to $t = 2$

(4)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

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