| Centre No. | | | | | | Paper Reference | | | | | | | Surname | Initial(s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Candidate No. | | | | | | E | G | 3 | 0 | 8 | / | 0 | 1 | Signature |

Paper Reference(s)

**EG308/01**

# Edexcel

## Principal Learning Engineering

Level 3

Unit 8: Mathematical Techniques and Applications for Engineers

Monday 8 June 2009 – Morning

Time: 1 hour 15 minutes

**Materials required for examination**
Ruler, pen, HB pencil, eraser, basic scientific calculator

**Items included with question papers**
Nil

Examiner's use only

Team Leader's use only

| Question Number | Leave Blank |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
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| Total | |

**Instructions to Candidates**

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature.
Check that you have the correct question paper.
Answer **ALL** the questions. Write your answers in the spaces provided in this question paper.
Supplementary answer sheets may be used.

**Information for Candidates**

The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 6 questions in this question paper. The total mark for this paper is 60.
There are 16 pages in this question paper. Any blank pages are indicated.
**Basic scientific calculators may be used.**

**Advice to Candidates**

Work steadily through the paper. Do not spend too long on one question. Show all stages in any calculations as marks will be awarded for these as well as the correct answer. If you cannot answer a question, leave it and attempt the next one.
Return at the end to those you have left out. You are reminded of the importance of clear English and careful presentation in your answers and correct use of SI units. You are advised to read the questions carefully.



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*Turn over*

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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

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

Integration

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

Leave blank

**Answer ALL SIX questions.**

**Write your answers in the spaces provided.**
**You must write down all stages in your working.**

**1.** (a) Make $u$ the subject of the expression $v^2 = u^2 + 2as$
and find $u$ when $v = 10$, $a = 9.81$ and $s = 3$.

.....

**(4)**

(b) Determine the value of $x$ from the equation
$2\log 3 + \log x = \log 36$

.....

**(3)**

Leave blank

(c) The current $i$ in a circuit is given by the equation $i = 10^{e}(\frac{-t}{\tau})$.
Given $\tau = 12$ calculate the time $t$ at which the current has fallen to 5A.

.....

**(3)**

Q1

**(Total 10 marks)**

Leave blank

**2.** (a) A car is moving away from a fixed point; the distance is measured and the values of distance $d$ and time $t$ are given in Table 1.
Use the data to complete the graph in Figure 1 and from this calculate the velocity of the object.
Determine the initial distance at $t$=0 s and the distance after 10 s.

| Time $t$ (s) | Distance $d$ (m) |
|---|---|
| 1 | 32 |
| 3 | 56 |
| 5 | 80 |
| 7 | 104 |

**Table 1**

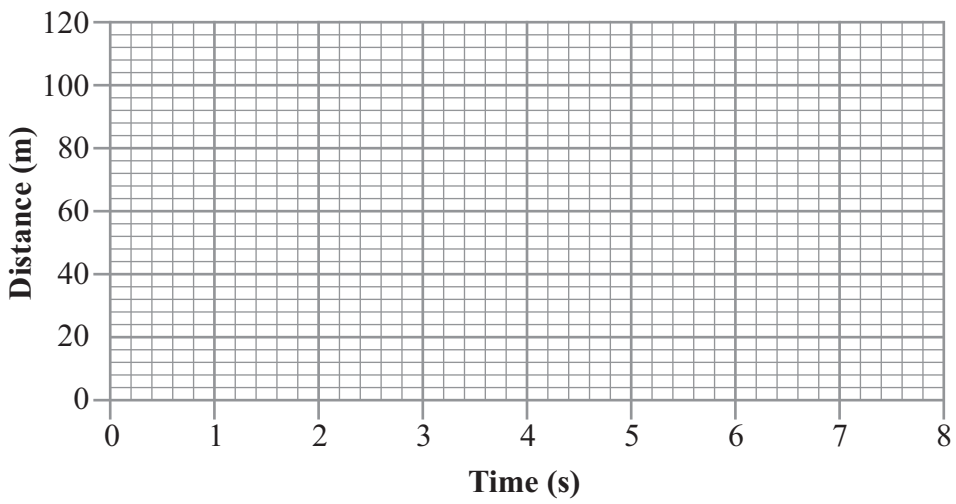



**Figure 1**

.....

**(5)**

Leave blank

(b) Use factorisation to simplify $\frac{a}{a^2 - b^2} - \frac{b}{a^2 - b^2}$.

.....

**(3)**

(c) The height $h$ of an object is given by the equation $h = x^2 + 3x - 10$.
Determine the 2 values of $x$ such that the height is zero.

.....

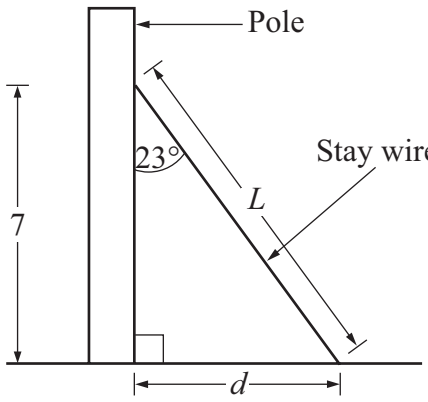
**(2)**

**Q2**

**(Total 10 marks)**

Leave blank

**3.** (a) Figure 2 shows a communications pole with a stay wire connected.
Calculate the distance $d$ between the base of the pole and the base of the stay wire and the length $L$ of stay wire required.




All dimensions in metres

**Figure 2**

.....

**(4)**

Leave blank

(b) A current is given by the equation $i = 3 + 2 \sin \theta$
Sketch **one** cycle of the waveform on Figure 3 and write down the value of the current when $\theta = 90°$

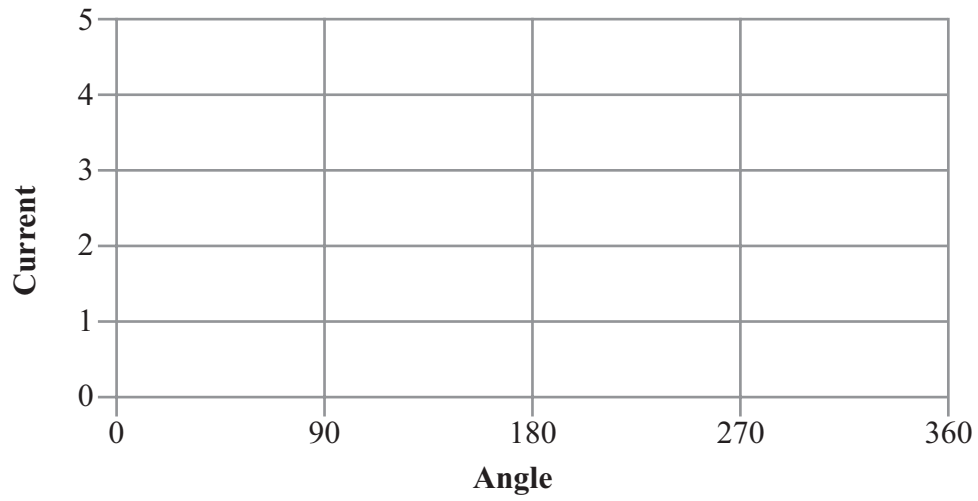
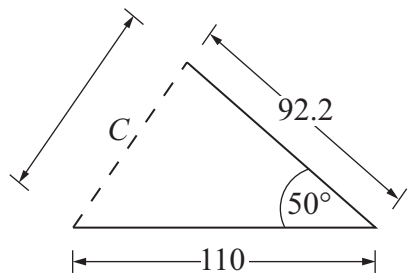



**Figure 3**

.....

**(3)**

(c) A CNC machine cuts a triangular shape from a steel plate as shown in Figure 4.
Calculate the length of side *C*.




All dimensions in millimetres

**Figure 4**

.....

**(3)**

**(Total 10 marks)**

**Q3**

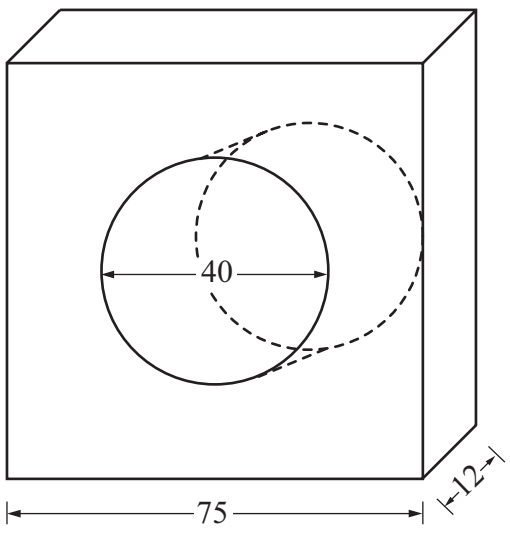




**Turn over**

Leave blank

**4.** (a) A square faced block of metal, as shown in Figure 5, has sides of 75 mm and thickness 12 mm.
A cylindrical hole of diameter 40 mm is cut through the centre of the block.
Calculate the total volume of metal.




All dimensions in millimetres

**Figure 5**

.....

**(3)**

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(b) Calculate the length of the drive-belt that is in contact with the 800 mm diameter drive-wheel in Figure 6.

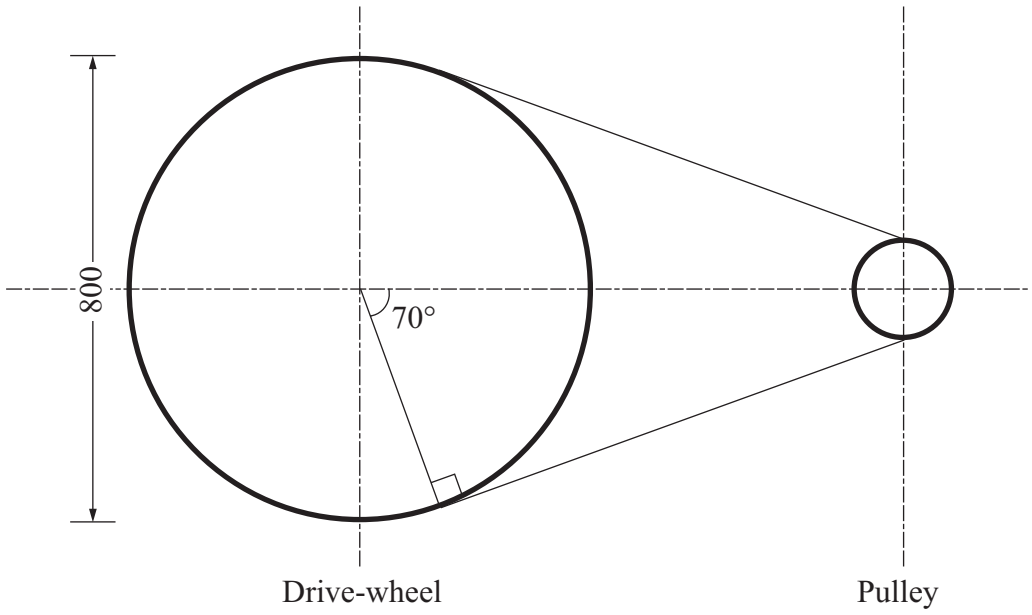


**Figure 6**

.....

**(4)**

(c) A flywheel is rotating at 500 radians per second.
Calculate this speed in rpm.

.....

**(3)**

**(Total 10 marks)**

**Q4**

Leave blank

**5.** 100 shafts with a nominal value of 20 mm diameter have been sampled and the values are given in Table 2.

(a) Use these values to draw the bar chart in Figure 7.

| **Diameter (mm)** | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|
| **Frequency** | 2 | 8 | 19 | 22 | 20 | 16 | 7 | 5 | 1 |

**Table 2**

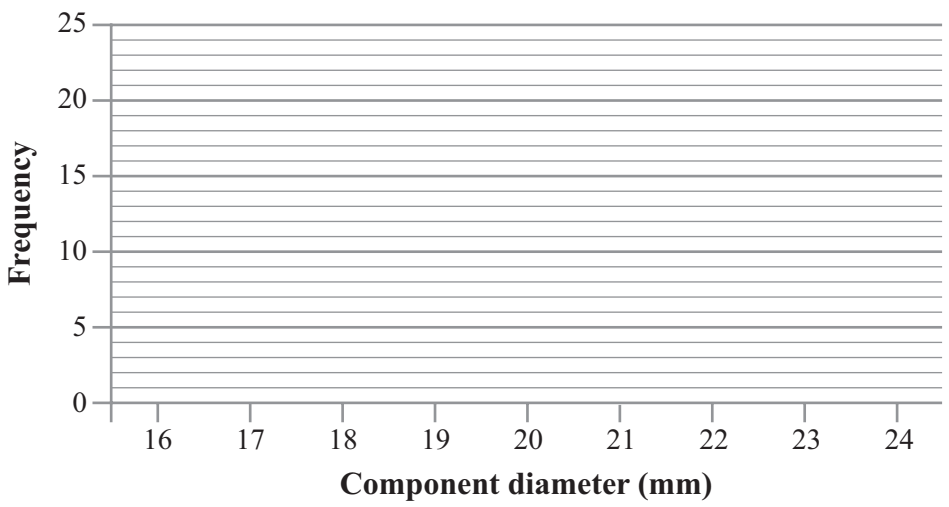


**Figure 7**

.....

**(3)**

Leave blank

(b) Determine the median, mode and mean values.

.....

**(5)**

(c) State **one** observation you can infer from the bar chart and calculations relative to the nominal value.

.....

.....

**(1)**

**(Total 9 marks)**

**Q5**

Leave blank

**6.** (a) Figure 8 shows the velocity of a projectile over the time $t = 0$ to $t = 5$.
Draw a tangent to the curve and use it to calculate the rate of change of velocity at $t = 2$.

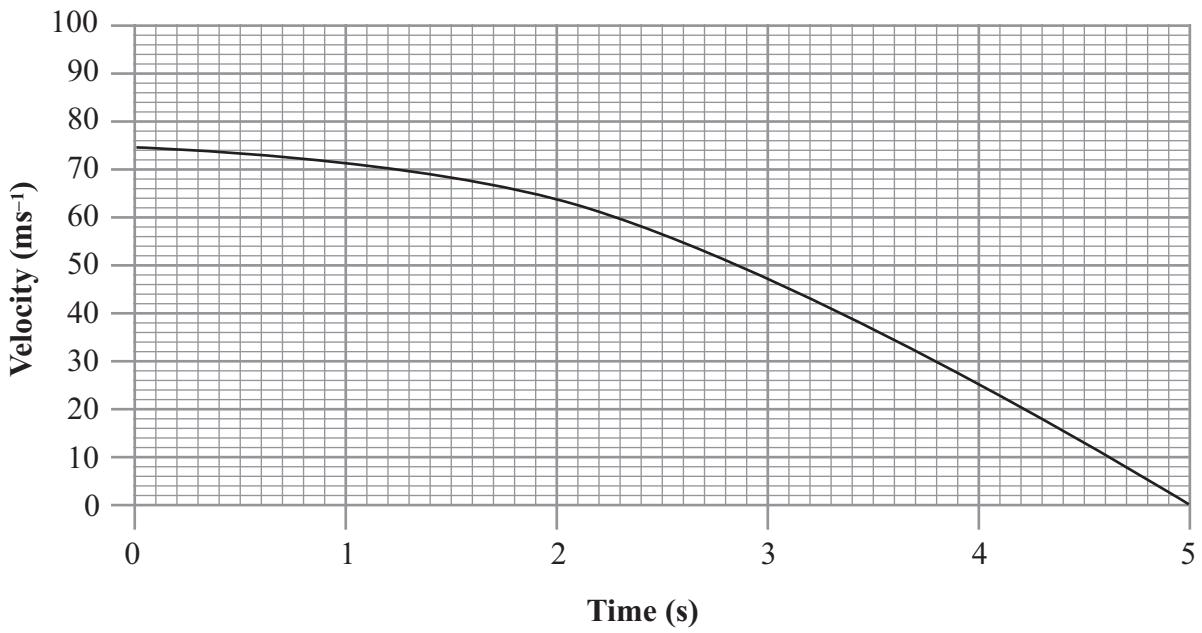


**Figure 8**

.....

**(4)**

Leave blank

(b) The equation for the velocity is $v = 75 - 3t^2$.
Use differentiation to produce an equation for the acceleration of the projectile and find the value of acceleration at $t = 2$.

.....

**(3)**

(c) Use integration to determine the distance travelled by the projectile during the time $t = 0$ to $t = 5$.

.....

**(4)**

**Q6**

**(Total 11 marks)**

**TOTAL FOR PAPER: 60 MARKS**

**END**

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