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**Edexcel**  
**Principal Learning**

Centre Number

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Candidate Number

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# Engineering

Level 3

## Unit 8: Mathematical Techniques and Applications for Engineers

Wednesday 18 January 2012 – 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.

Turn over ►

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**PEARSON**

## Laws of indices

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

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

$$(a^m)^n = a^{mn}$$

## 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     | $\frac{1}{3}\pi r^2 h$ | $\pi r \times \text{slant height}$ |



## 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

$$y \quad \frac{dy}{dx}$$

$$x^n \quad nx^{n-1}$$

$$a \sin kx \quad ka \cos kx$$

$$a \cos kx \quad -ka \sin kx$$

$$ae^{kx} \quad kae^{kx}$$

### Integration

$$y \quad \int y dx$$

$$x^n \quad \frac{x^{n+1}}{n+1} \quad (n \neq -1)$$

$$a \sin kx \quad -\frac{a}{k} \cos kx$$

$$a \cos kx \quad \frac{a}{k} \sin kx$$

$$ae^{kx} \quad \frac{a}{k} e^{kx}$$



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

**1** (a) Given that  $v^2 = u^2 + 2as$

(i) make  $a$  the subject of the equation

(2)

(ii) find the value of  $v$  when  $u = 2$ ,  $a = 4$  and  $s = 16$

(2)



- (b) Using the laws of logarithms, determine the value of  $x$  from the equation  
 $\log 12 = \log x + 2 \log 2$

(3)

- (c) The following relationship relates to a flat belt drive:

$$T_1 = T_2 e^{u\theta}$$

Determine the value of  $u$  when  $T_1 = 400$ ,  $T_2 = 175$  and  $\theta = 3.22$

(3)

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(Total for Question 1 = 10 marks)



P 4 0 7 0 1 A 0 5 1 6

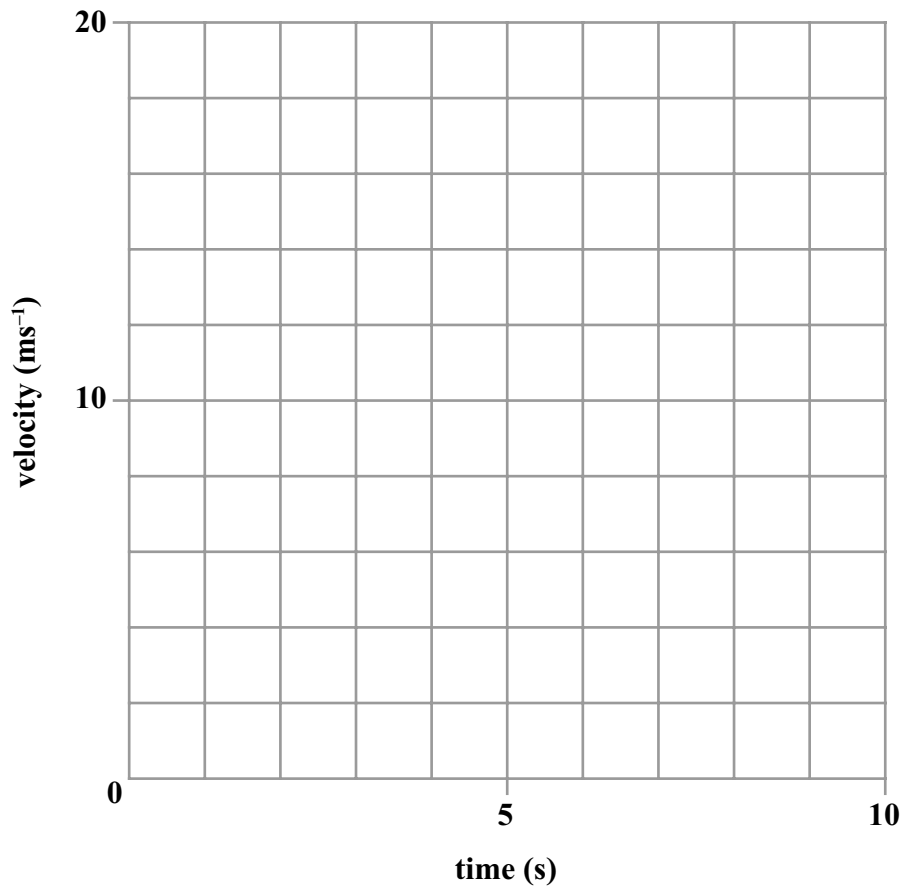
2 (a) The data in Table 1 below was obtained from an observation of a vehicle in motion.

|                               |   |    |    |    |    |
|-------------------------------|---|----|----|----|----|
| Time (seconds)                | 2 | 4  | 6  | 8  | 10 |
| Velocity ( $\text{ms}^{-1}$ ) | 7 | 10 | 13 | 16 | 19 |

**Table 1**

(i) Use the data in Table 1 to plot the graph.

(1)



(ii) Determine the equation of the straight line.

(3)

(iii) The vehicle continues to accelerate at the same rate. Using your equation, calculate the velocity of the vehicle at 22.5 seconds.

(1)



(b) The area of a component is given by the formula  $\pi rh + \pi r^2$

Factorise the formula.

(2)

(c) Production output of components made in a factory can be determined from the formula:

$$\text{components made} = x(x + 2)$$

When the output is 99 components, calculate the value of  $x$ .

(4)

(Total for Question 2 = 11 marks)



- 3 (a) Figure 1 shows a radio mast observed from a point on a horizontal plane 100 m from the base of the mast. At this point, the angle from the ground to the top of the mast is  $16^\circ$ .

Calculate the height  $h$  of the mast.

(2)

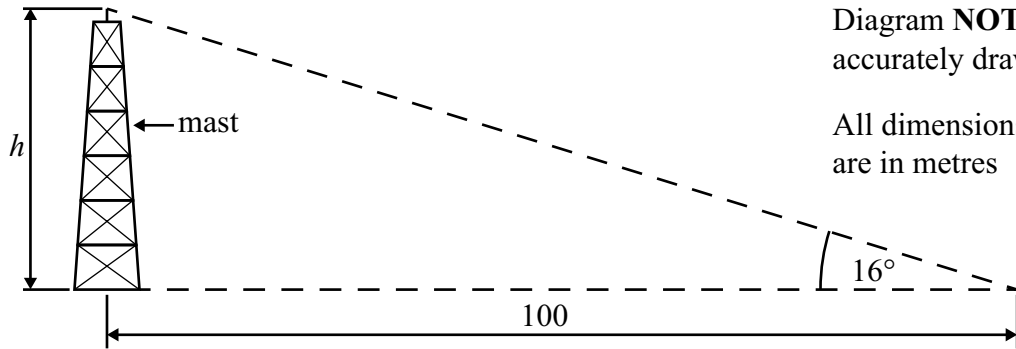


Diagram **NOT** accurately drawn  
All dimensions are in metres

Figure 1

Space for working

Answer: .....

- (b) Determine the horizontal and vertical components of the vector  $v$  shown in Figure 2.

(4)

Diagram **NOT** accurately drawn

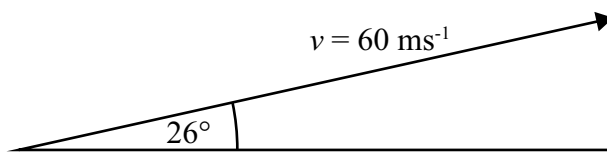


Figure 2

Space for working

Answer: .....





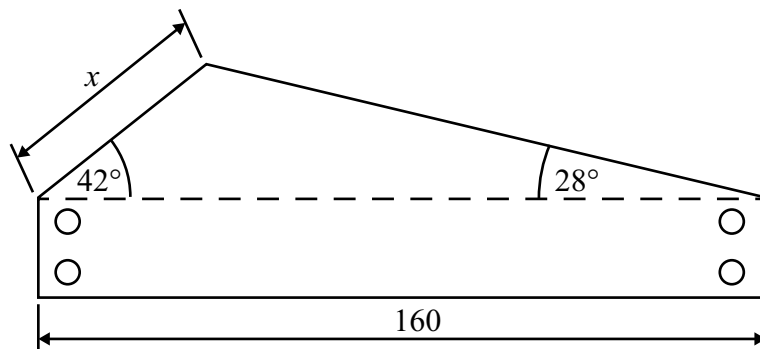
(c) A flat sheet metal component is shown in Figure 3.

Determine the length of side  $x$ .

(4)

Diagram **NOT**  
accurately drawn

All dimensions  
are in millimetres



**Figure 3**

Space for working

Answer: .....

**(Total for Question 3 = 10 marks)**



4 (a) A locking plate is made from material  $70\text{mm} \times 40\text{mm} \times 5\text{mm}$ .

Figure 4 shows two views of the finished component.

Calculate the volume of the finished component.

(4)

Diagram **NOT**  
accurately drawn

All dimensions  
are in millimetres

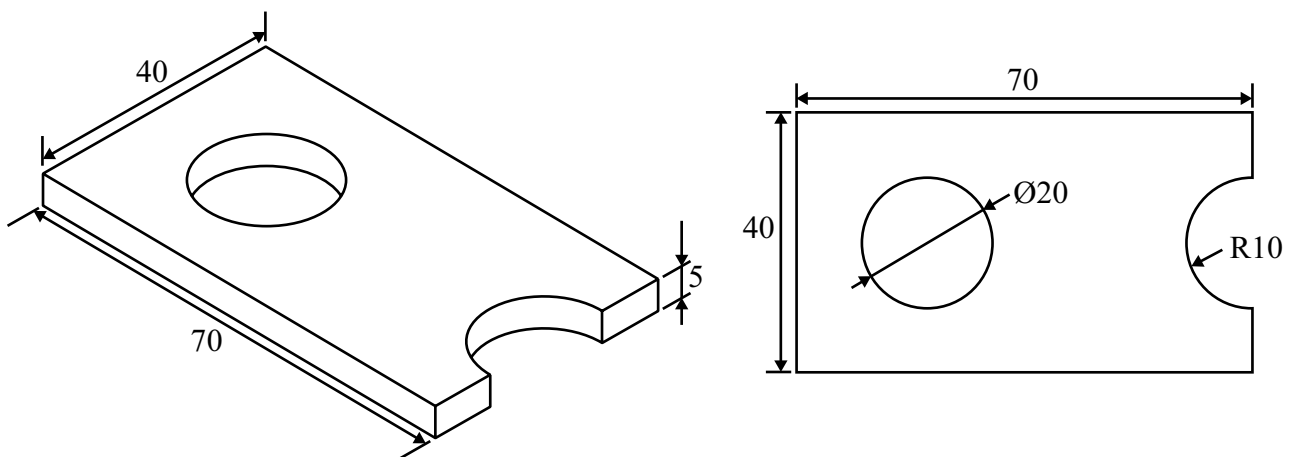


Figure 4

Space for working

Answer: .....



(b) A cam rotates through an angle of 2.25 radians before activating a switch.

Calculate this angle to the nearest degree.

(2)

(c) The speed of a motor is recorded at 155 radians per second.

Calculate the speed of the motor in revolutions per minute.

(3)

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(Total for Question 4 = 9 marks)



5 Car bulb data is shown in Table 2.

| Bulb type               | Rating W (watts) |
|-------------------------|------------------|
| Headlights              | 60               |
| Rear fog light          | 21               |
| Number plate light      | 5                |
| Front fog light         | 55               |
| Stop lights             | 21               |
| Boot lid light          | 10               |
| Seat belt warning light | 2                |
| Indicators              | 21               |
| Tail light              | 5                |

**Table 2**

(a) State the modal value. (1)

(b) Determine the median value.  
You must show your working. (2)

(c) Calculate the mean value.  
You must show your working. (3)



(d) Explain the term 'central tendency' when used in data analysis.

(2)

.....

.....

.....

.....

(e) What would happen to the median value if the rear fog light was removed from this data?

(1)

.....

.....

**(Total for Question 5 = 9 marks)**



6 (a) A curve is drawn where  $y = x^3$

Differentiate the expression and find the gradient of the curve when  $x = 4$

(3)

(b) The distance moved by a piston can be determined by  $s = 6t + 2t^2$

Using calculus, produce an equation for the velocity of the piston and determine the velocity when  $t = 2\text{s}$

(4)



(c) Figure 5 represents a graph of a moving vehicle.

The equation of the line is  $v = 2t + 3$

The hatched area represents the distance travelled between  $t = 0$  and  $t = 8$  seconds.

Using integration, determine the distance travelled by the vehicle.

(4)

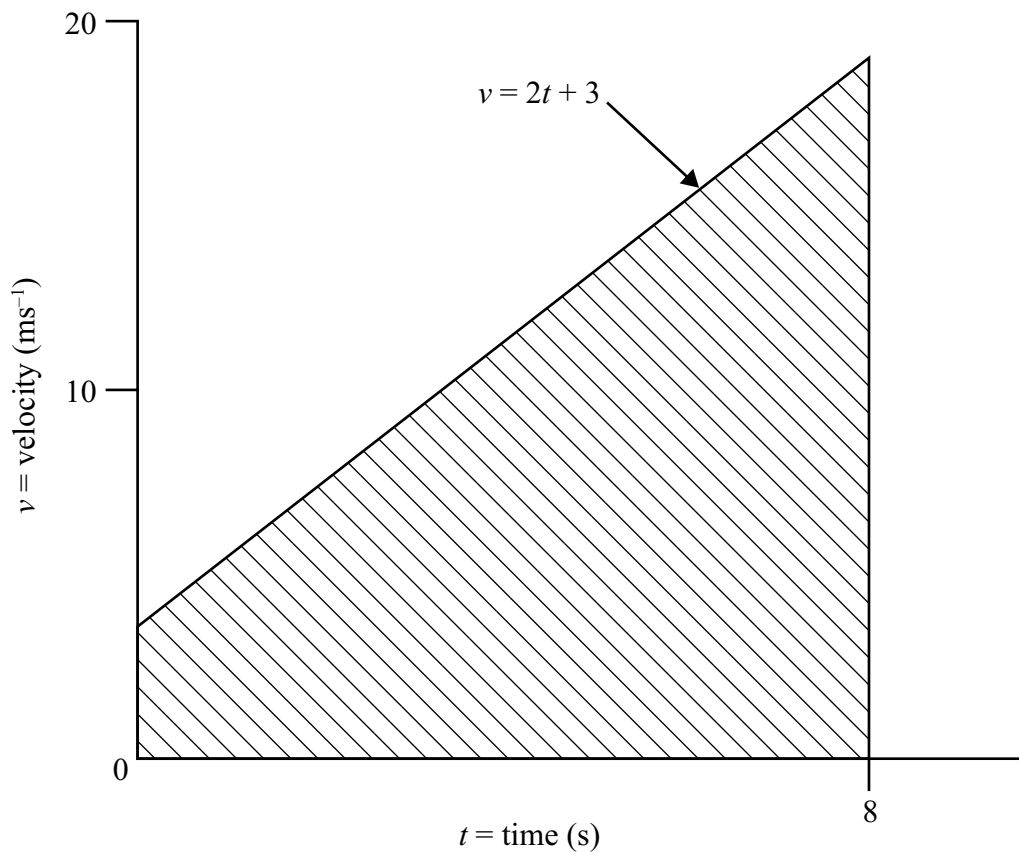


Figure 5 (NOT TO SCALE)

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(Total for Question 6 = 11 marks)

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**TOTAL FOR PAPER = 60 MARKS**



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