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 17 January 2013 – Morning
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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5/5/5/6/6/6

P 4 2 0 3 0 A 0 1 2 0

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) Simplify the expression $\frac{b^7}{b^3}$ giving the answer in index form.

(2)

(b) The change in length, x, of a copper rod can be found from $x = l\,\alpha\,\Delta t$

Where

l is the original length

α is the coefficient of linear expansion and

Δt is the change in temperature.

If the original length of the rod is 200 mm and the temperature is raised by 25°C, determine the coefficient of linear expansion when the change in length is 0.08 mm.

(3)

(c) Using the laws of logarithms, determine the value of x from the equation

$\log 36 - \log x = 2 \log 2$

(3)

(d) The tension of a belt on a pulley can be found from the equation $T_1 = 24e^{1.39\mu}$, where μ is the coefficient of friction between the belt and the pulley.

Calculate the coefficient μ, when $T_1 = 34$ newtons.

(3)

(Total for Question 1 = 11 marks)

2 (a) A load-extension test for a spring produced results, a range of which is shown in Table 1.

Load (N)	184	194	204	214	224	234	244	254	264
Extension (mm)	15	16	17	18	19	20	21	22	23

Table 1

(i) Use the data in Table 1 to plot a load-extension graph on Figure 1.

(1)

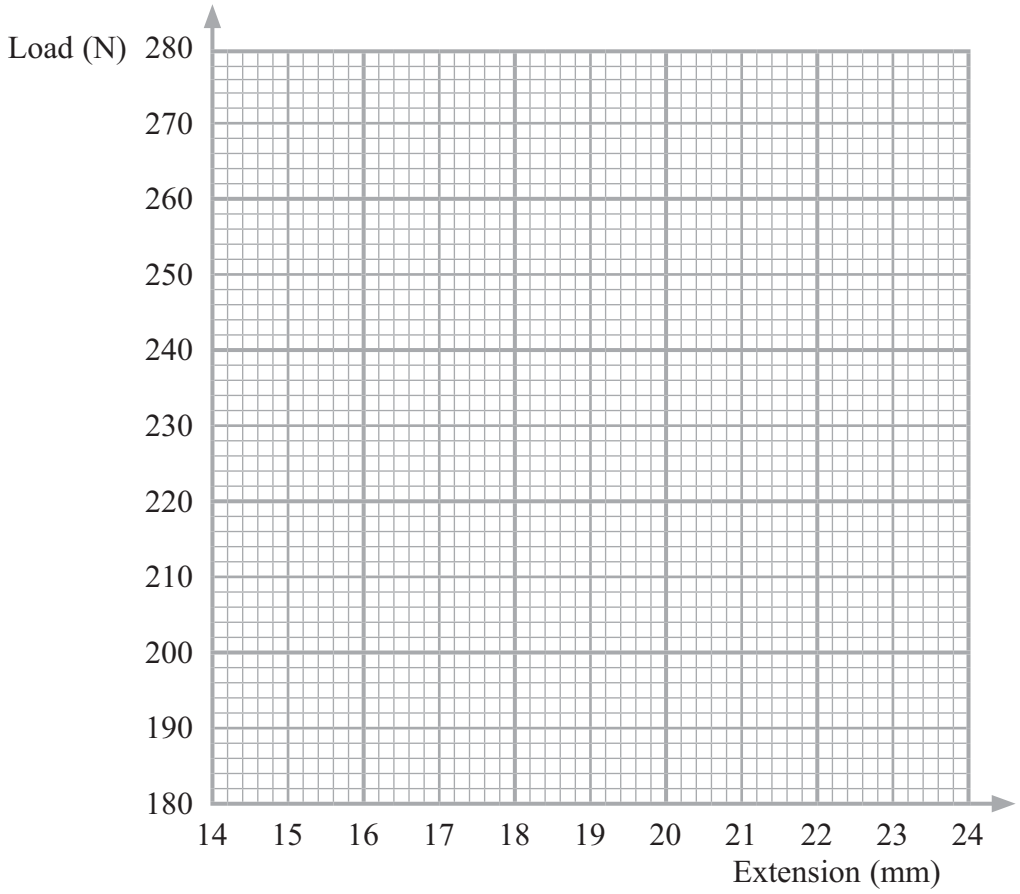

Figure 1

(ii) Determine the equation of the straight line.

(3)

(iii) Calculate the load that produces an extension of 4.75 mm.

(2)

(b) The volume of an aluminium tube can be found from the formula $\frac{\pi}{4} D^2h - \frac{\pi}{4} d^2h$.

Fully factorise $\frac{\pi}{4} D^2h - \frac{\pi}{4} d^2h$.

(2)

(c) Results from a test track show that the velocity (v), of a high performance vehicle at time (t) after starting, is given by $v = 2.5t^2 - 25t$.

Determine the time for the vehicle to reach a velocity of 60 ms^{-1}.

(3)

(Total for Question 2 = 11 marks)

3 (a) A tangent curve of $y = \tan\theta$ is shown in Figure 2, for angles between 0° and 360°.

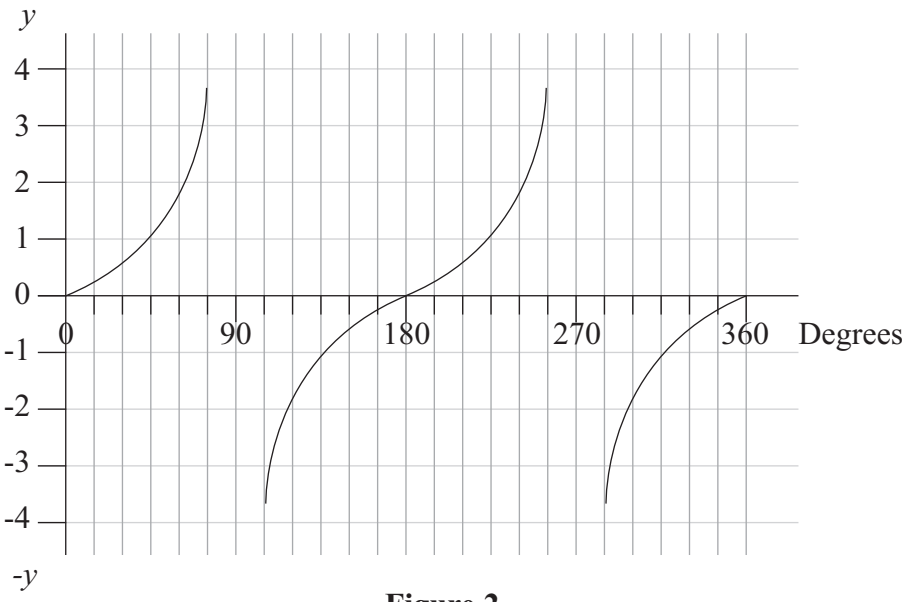

Figure 2

From the graph determine the value of the angles in degrees, between 0° and 360°, for which $\tan\theta = +1$.

(2)

(b) Calculate the height, h, of the ventilation pipe shown in Figure 3.

(3)

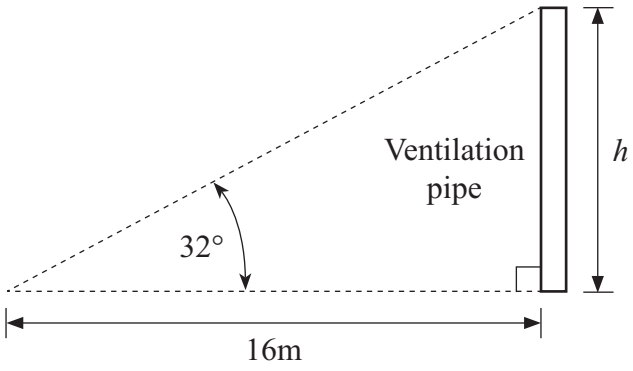

Diagram **NOT** drawn to scale

Figure 3

Space for working

Answer: .....

(c) Two forces, F_1 and F_2, act at a point as shown in Figure 4. These can be represented on a diagram, shown in Figure 5 and the resultant obtained from the length of R_F.

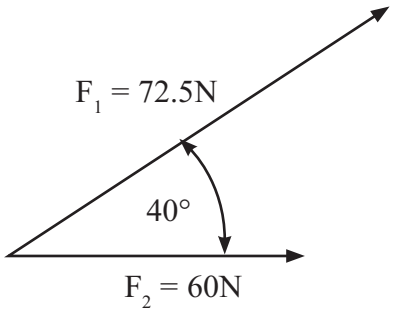

Figure 4

Diagram **NOT** drawn to scale

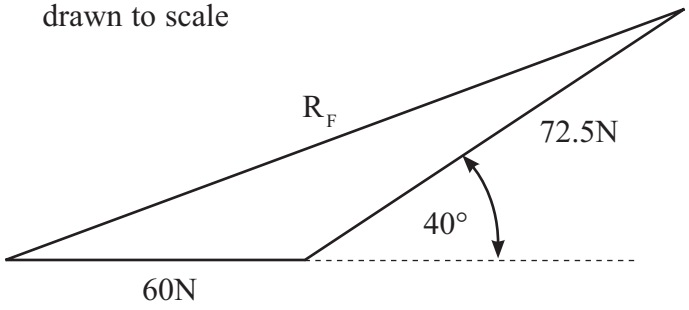

Figure 5

Calculate the length R_F.

(4)

Space for working

Answer: .....

(Total for Question 3 = 9 marks)

4 (a) A cam plate in the shape of a sector of a circle is shown in Figure 6. The radius of the plate is 40 mm and the thickness is 5 mm. A rectangular location slot 12 mm × 3 mm is machined through the cam as shown.

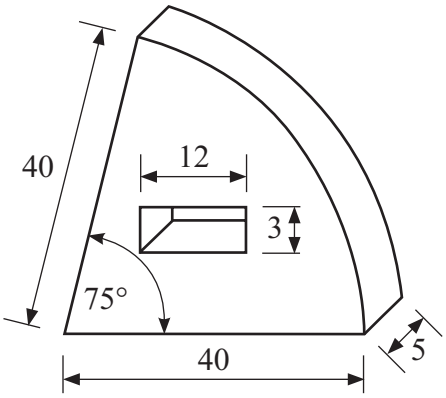

Diagram **NOT** drawn to scale

All dimensions are in millimetres

Figure 6

Determine the volume of the cam plate.

(4)

Space for working

Answer: .....

(b) A washing machine belt system is shown in Figure 7. Two points, P and Q, 150° apart indicate the section of the pulley that the belt touches. If the length of belt between P and Q on this pulley is 523.5 mm, calculate the diameter of pulley A.

(4)

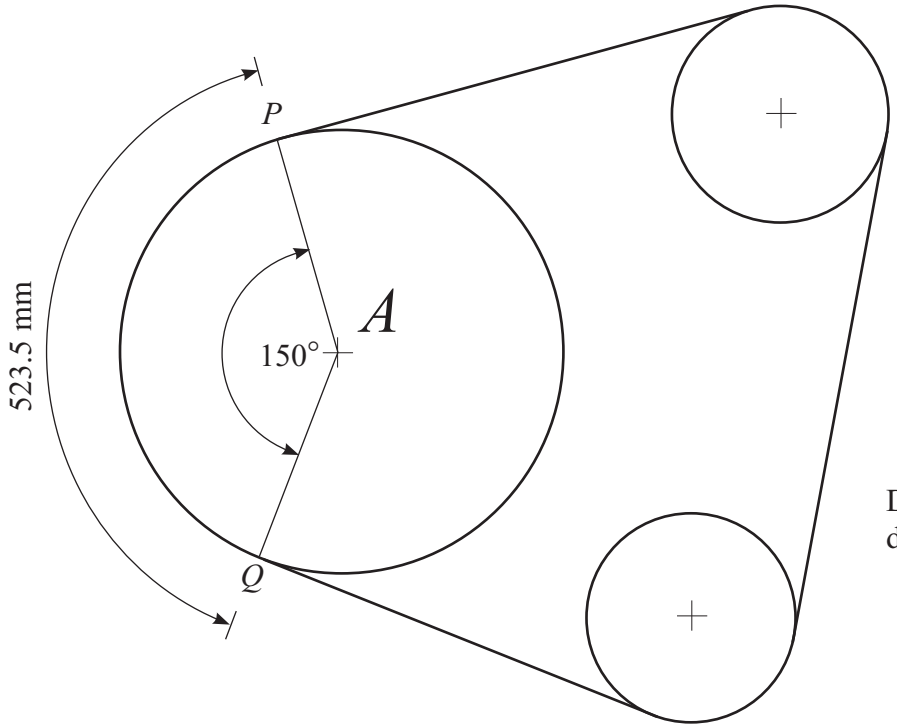

Diagram **NOT** drawn to scale

Figure 7

Space for working

Answer: .....

(Total for Question 4 = 8 marks)

5 Rechargeable battery packs for portable equipment were checked for voltage level during a maintenance activity. The data is shown in Table 2.

Voltage Range	$4 < 6$	$6 < 8$	$8 < 10$	$10 < 12$	$12 < 14$
Frequency (number of rechargeable battery packs)	3	5	7	4	3

Table 2

The data has been plotted with the mid-range values identified in the histogram below.

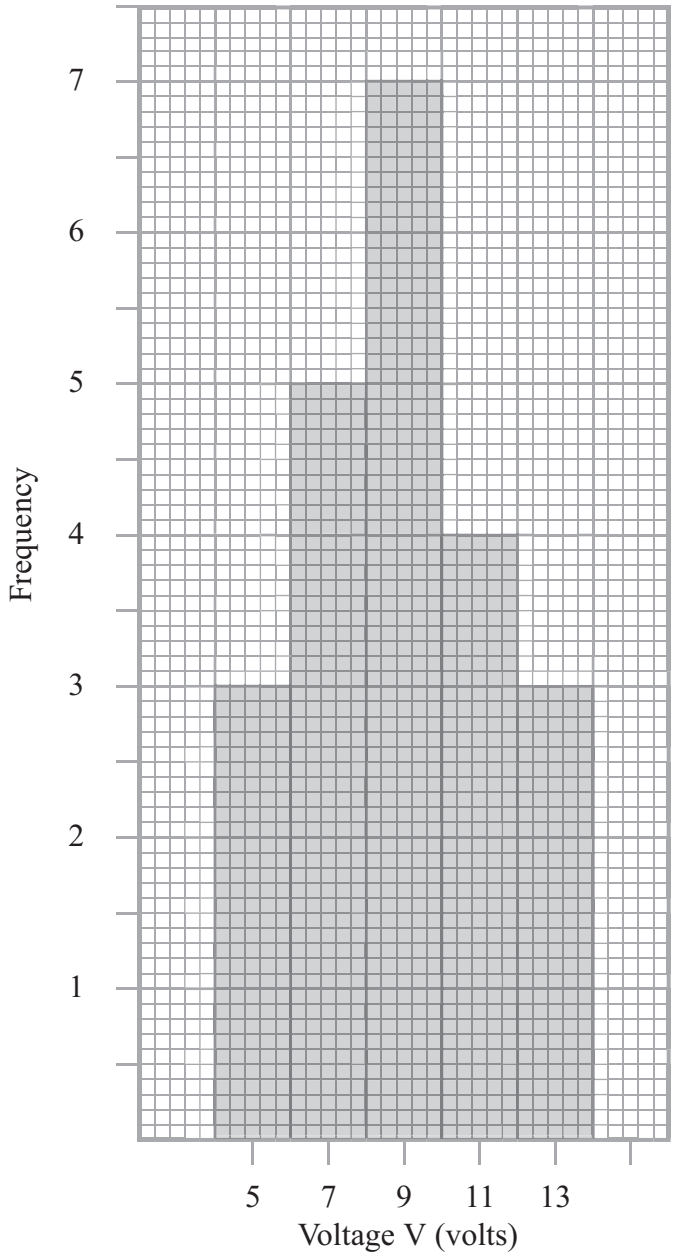

Figure 8

(a) From the histogram, obtain the value of the mode.

(2)

(b) Calculate the mean voltage.

(3)

Space for working

Answer: .....

(c) Table 3 shows results from another series of tests. Complete Table 3 to show the cumulative frequency values for the data.

(1)

Voltage Range	Frequency (number of rechargeable battery packs)	Cumulative Frequency
4<6	2	
6<8	4	
8<10	7	
10<12	6	
12<14	3	

Table 3

(d) (i) Use the values from Table 3 to draw a cumulative frequency graph on Figure 9.

(2)

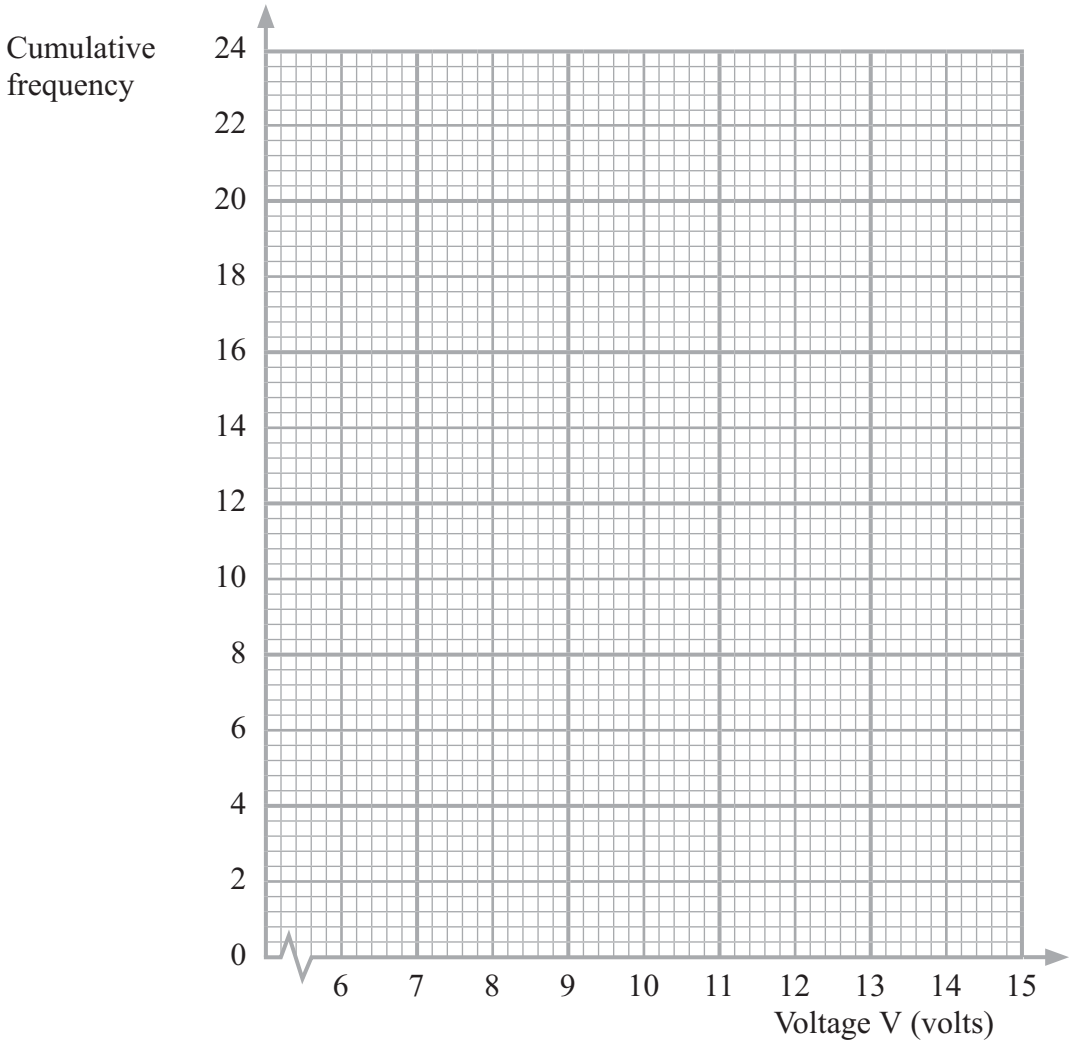

Figure 9

(ii) Determine the median

(2)

(Total for Question 5 = 10 marks)

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6 (a) Figure 10 shows the velocity of a car as it accelerates.

(i) Draw a tangent to the curve at $t = 2.5$ s

(1)

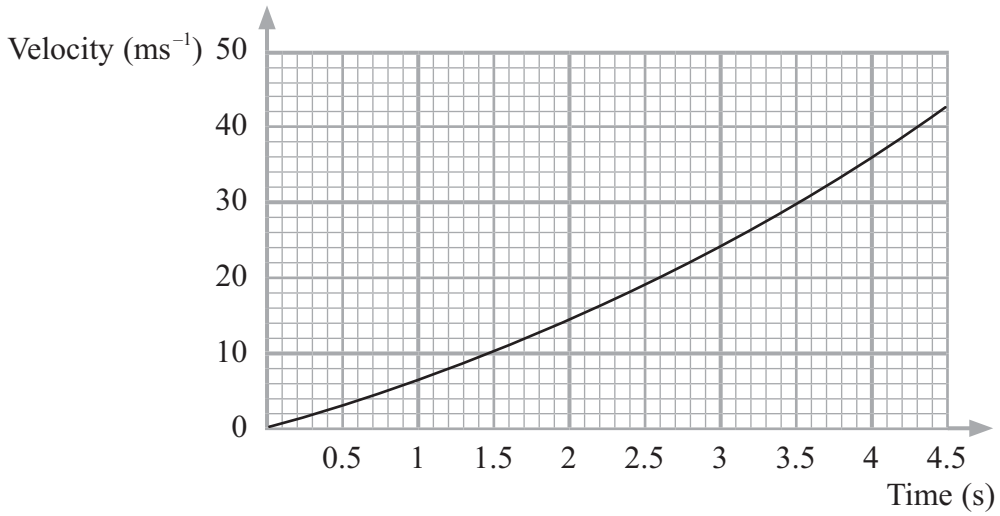

Figure 10

(ii) Determine the rate of change of velocity at time $t = 2.5$ s

(3)

(b) The velocity, v, of a rocket is given by

$v = 25t + 3t^2$.

Use differentiation to produce an equation for the acceleration of the rocket and determine its acceleration after 8 seconds.

(3)

(c) Using calculus, determine the distance travelled by the rocket in the first 8 seconds.

(4)

(Total for Question 6 = 11 marks)

TOTAL FOR PAPER = 60 MARKS

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