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Surname	Other names
<b>Pearson Edexcel</b>	Centre Number
<b>International GCSE</b>	Candidate Number
<h1 style="margin: 0;">Further Pure Mathematics</h1> <h2 style="margin: 0;">Paper 2</h2>	
Monday 22 January 2018 – Morning <b>Time: 2 hours</b>	Paper Reference <b>4PM0/02</b>
<b>Calculators may be used.</b>	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.
- Without sufficient working, correct answers may be awarded no marks.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*

### Information

- The total mark for this paper is 100.
- 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.
- Check your answers if you have time at the end.

Turn over ►

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**Pearson**

Answer all ELEVEN questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1

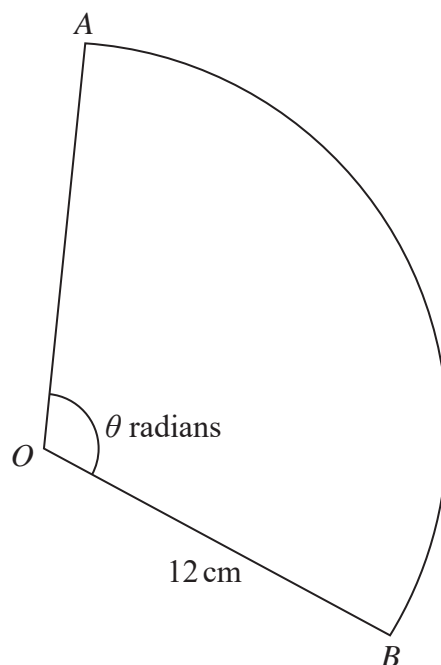


Diagram **NOT**  
accurately drawn

Figure 1

Figure 1 shows the sector  $AOB$  of a circle with centre  $O$  and radius 12 cm. The angle  $AOB$  is  $\theta$  radians and the area of the sector is  $192 \text{ cm}^2$

Calculate

(a) the value of  $\theta$ ,

(2)

(b) the length, in cm, of the arc  $AB$ .

(2)

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**(Total for Question 1 is 4 marks)**



2 (a) Show that  $\sum_{r=1}^n (3r + 2) = \frac{n}{2} (7 + 3n)$  (2)

(b) Hence, or otherwise, evaluate  $\sum_{r=10}^{20} (3r + 2)$  (3)

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**Question 2 continued**

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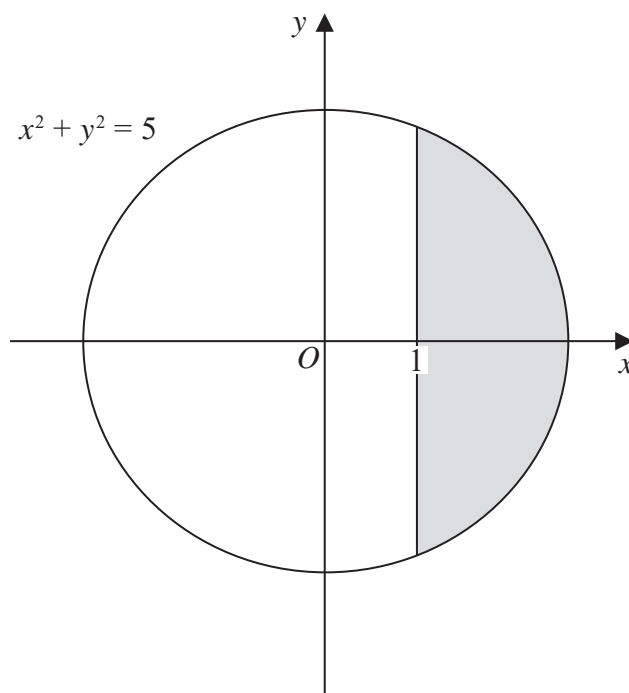
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**(Total for Question 2 is 5 marks)**

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3

Diagram **NOT**  
accurately drawn**Figure 2**

The region enclosed by the circle with equation  $x^2 + y^2 = 5$  and the straight line with equation  $x = 1$ , shown shaded in Figure 2, is rotated through  $360^\circ$  about the  $y$ -axis.

Use algebraic integration to find the exact volume of the solid generated.

(5)

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**Question 3 continued**

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**(Total for Question 3 is 5 marks)**



4 Here is a quadratic equation  $3x^2 + px + 4 = 0$  where  $p$  is a constant.

(a) Find the set of values of  $p$  for which the equation has two real distinct roots.

(5)

(b) List all the possible integer values of  $p$  for which the equation has no real roots.

(1)

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**Question 4 continued**

Area for writing answers to Question 4 continued. The area contains horizontal dotted lines for writing.

**(Total for Question 4 is 6 marks)**

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5 Given that  $y = 2e^x(3x^2 - 6)$

show that  $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = 12e^x$

(7)

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**Question 5 continued**

Area for writing answers to Question 5 continued. The area contains horizontal dotted lines for writing.

**(Total for Question 5 is 7 marks)**

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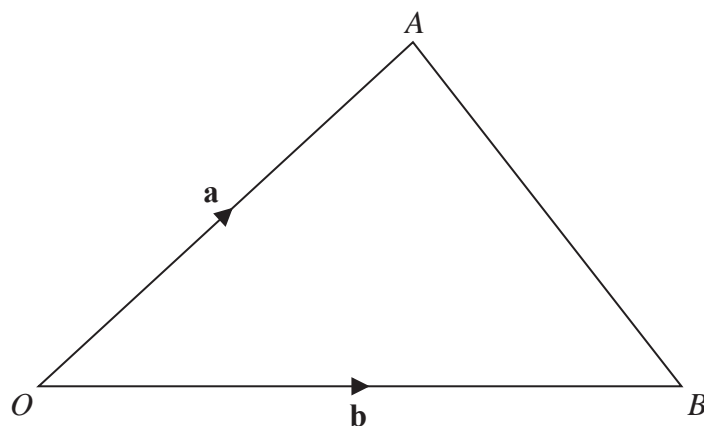
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Figure 3

Figure 3 shows the triangle  $OAB$  with  $\vec{OA} = \mathbf{a}$  and  $\vec{OB} = \mathbf{b}$ .

- (a) Find  $\vec{AB}$  in terms of  $\mathbf{a}$  and  $\mathbf{b}$ .

(1)

The point  $P$  is such that  $\vec{OP} = \frac{3}{4}\vec{OA}$ , and the point  $Q$  is the midpoint of  $AB$ .

- (b) Find  $\vec{PQ}$  as a simplified expression in terms of  $\mathbf{a}$  and  $\mathbf{b}$ .

(2)

The point  $R$  is such that  $PQR$  and  $OBR$  are straight lines where

$$\vec{QR} = \mu\vec{PQ} \quad \text{and} \quad \vec{BR} = \lambda\vec{OB}$$

- (c) Express  $\vec{QR}$  in terms of

(i)  $\mathbf{a}$ ,  $\mathbf{b}$  and  $\mu$

(ii)  $\mathbf{a}$ ,  $\mathbf{b}$  and  $\lambda$

(3)

- (d) Hence find the value of

(i)  $\mu$

(ii)  $\lambda$

(4)

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**Question 6 continued**

Area for writing answers to Question 6 continued.



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**Question 6 continued**

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**Question 6 continued**

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**(Total for Question 6 is 10 marks)**



7 (i) Solve the equation  $\frac{(8^x)^x}{32^x} = 4$

(4)

(ii) Solve the equation  $\log_x 64 + 3 \log_4 x - \log_x 4 = 5$

(7)

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**Question 7 continued**

Handwritten answer area for Question 7 continued, consisting of 25 horizontal dotted lines.



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**Question 7 continued**

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**Question 7 continued**

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**(Total for Question 7 is 11 marks)**



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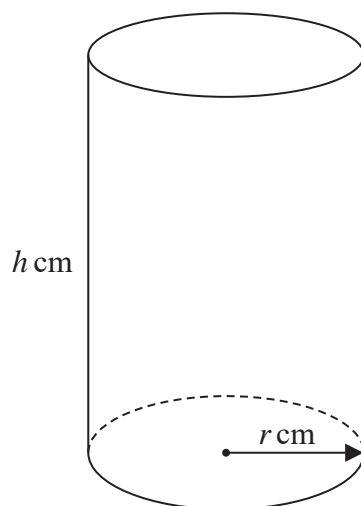
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Figure 4

A solid right circular cylinder has radius  $r$  cm and height  $h$  cm, as shown in Figure 4. The cylinder has a volume of  $355 \text{ cm}^3$  and a total surface area of  $S \text{ cm}^2$

- (a) Show that  $S = 2\pi r^2 + \frac{710}{r}$  (4)

Given that  $r$  can vary,

- (b) using calculus find, to 3 significant figures, the minimum value of  $S$ . (5)
- (c) Verify that your answer to part (b) does give the minimum value of  $S$ . (2)

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**Question 8 continued**

Handwriting practice area with horizontal dotted lines.



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**Question 8 continued**

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**Question 8 continued****(Total for Question 8 is 11 marks)**

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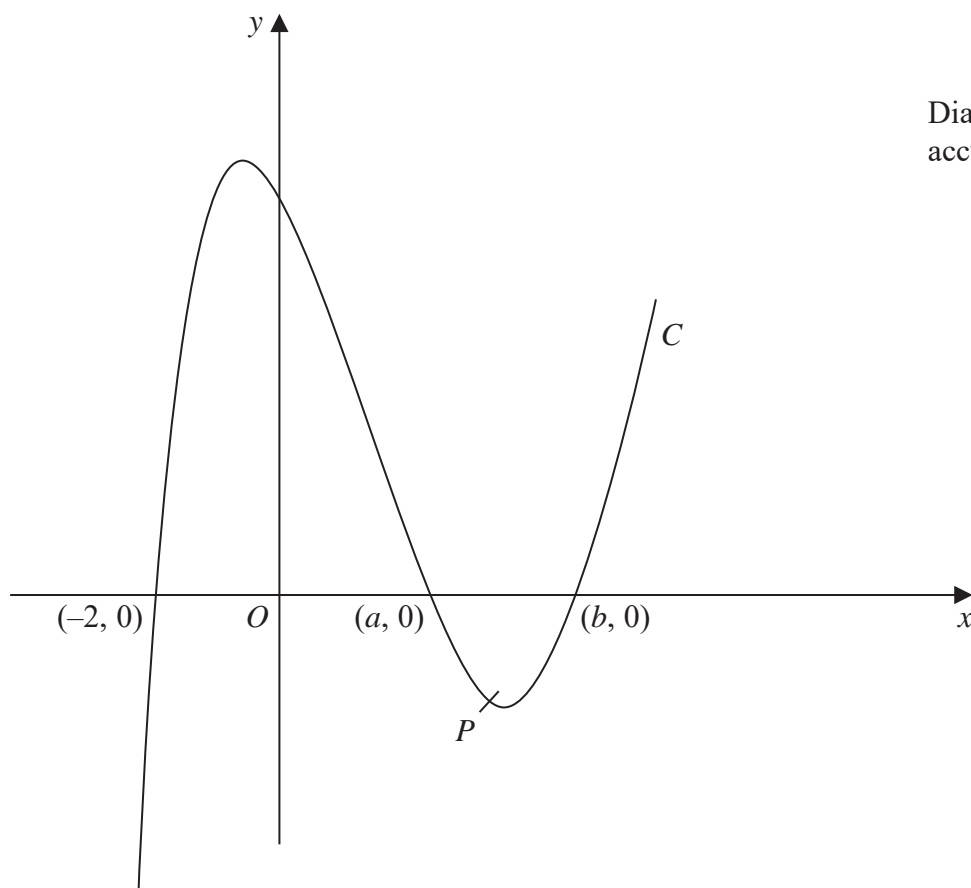
Diagram **NOT**  
accurately drawn**Figure 5**

Figure 5 shows the curve  $C$  with equation  $y = x^3 - 2x^2 - 5x + 6$

The curve  $C$  crosses the  $x$ -axis at the points with coordinates  $(-2, 0)$ ,  $(a, 0)$  and  $(b, 0)$

(a) (i) Show that  $a = 1$

(ii) Find the value of  $b$ .

(4)

The point  $P$  on  $C$  has  $x$  coordinate 2 and the line  $l$  is the tangent to  $C$  at  $P$ .

(b) Show that  $l$  crosses the  $x$ -axis at the point with coordinates  $(-2, 0)$

(6)

(c) Use algebraic integration to find the exact area of the finite region bounded by  $C$  and  $l$ .

(4)

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**Question 9 continued**

Handwriting practice area with horizontal dotted lines.



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**Question 9 continued**

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**Question 9 continued****(Total for Question 9 is 14 marks)**

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- 10 The point  $A$  has coordinates  $(-6, -4)$  and the point  $B$  has coordinates  $(4, 1)$   
The line  $l$  passes through the point  $A$  and the point  $B$ .

(a) Find an equation of  $l$ .

(2)

The point  $P$  lies on  $l$  such that  $AP:PB = 3:2$

(b) Find the coordinates of  $P$ .

(2)

The point  $Q$  with coordinates  $(m, n)$  lies on the line through  $P$  that is perpendicular to  $l$ .

Given that  $m < 0$  and that the length of  $PQ$  is  $3\sqrt{5}$

(c) find the coordinates of  $Q$ .

(5)

The point  $R$  has coordinates  $(-13, 0)$

(d) Show that

(i)  $AB$  and  $RQ$  are equal in length,

(ii)  $AB$  and  $RQ$  are parallel.

(4)

(e) Find the area of the quadrilateral  $ABQR$ .

(2)

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**Question 10 continued**

Area for writing answers to Question 10 continued.



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**Question 10 continued**

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**(Total for Question 10 is 15 marks)**

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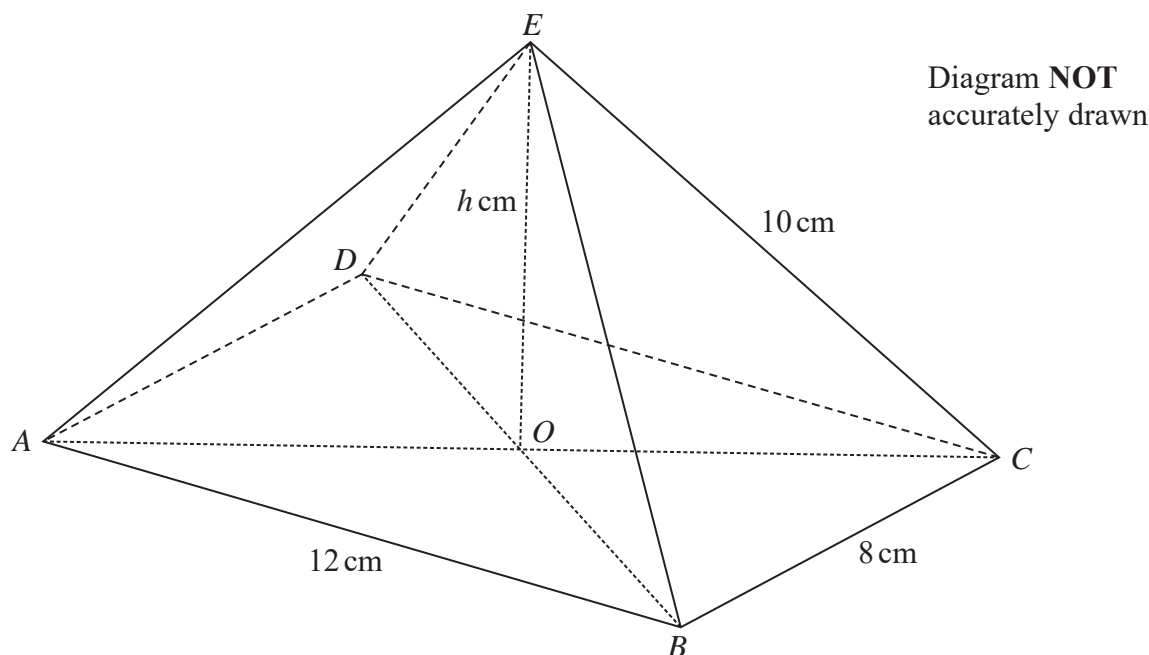


Figure 6

A pyramid with a rectangular base  $ABCD$  and vertex  $E$  is shown in Figure 6.

The rectangular base is horizontal with  $AB = 12$  cm and  $BC = 8$  cm.

The diagonals of the base intersect at the point  $O$ .

The vertex  $E$  of the pyramid is vertically above  $O$ .

The height of the pyramid is  $h$  cm and  $AE = BE = CE = DE = 10$  cm.

(a) Show that  $h = 4\sqrt{3}$  (3)

(b) Find, in degrees to 1 decimal place, the size of angle  $OCE$ . (2)

The angle between  $OE$  and the plane  $CBE$  is  $\theta^\circ$

(c) Show that  $\cos \theta^\circ = \frac{2\sqrt{7}}{7}$  (3)

The point  $P$  is the midpoint of  $BE$  and the point  $Q$  is the midpoint of  $CE$ .

(d) Find, in degrees to 1 decimal place, the size of the angle between the plane  $OPQ$  and the plane  $EPQ$ . (4)

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**Question 11 continued**

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**Question 11 continued**

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**Question 11 continued**

Area for writing answers to Question 11 continued.



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**Question 11 continued**

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(Total for Question 11 is 12 marks)

**TOTAL FOR PAPER IS 100 MARKS**

