

Please check the examination details below before entering your candidate information

Candidate surname				Other names							
Pearson Edexcel				Centre Number				Candidate Number			
Level 3 GCE				<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>				<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>			
Time 1 hour 40 minutes				Paper reference				8FM0/01			
Further Mathematics											
Advanced Subsidiary											
PAPER 1: Core Pure Mathematics											
You must have: Mathematical Formulae and Statistical Tables (Green), calculator										Total Marks	

Candidates may use any calculator allowed by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided
– *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Inexact answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 9 questions in this question paper. The total mark for this paper is 80.
- 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.
- Try to answer every question.
- Check your answers if you have time at the end.
- Good luck with your examination.

Turn over ►



$$1. \quad \mathbf{P} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \quad \mathbf{Q} = \begin{pmatrix} 1 & 0 \\ 0 & 3 \end{pmatrix}$$

(a) (i) Describe fully the single geometrical transformation P represented by the matrix \mathbf{P} .

(ii) Describe fully the single geometrical transformation Q represented by the matrix \mathbf{Q} . (4)

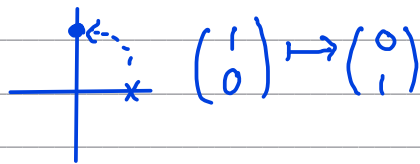
The transformation P followed by the transformation Q is the transformation R , which is represented by the matrix \mathbf{R} .

(b) Determine \mathbf{R} . (1)

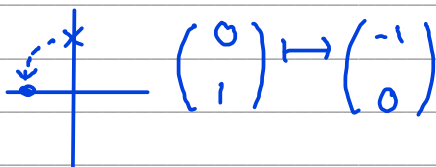
(c) (i) Evaluate the determinant of \mathbf{R} .

(ii) Explain how the value obtained in (c)(i) relates to the transformation R . (2)

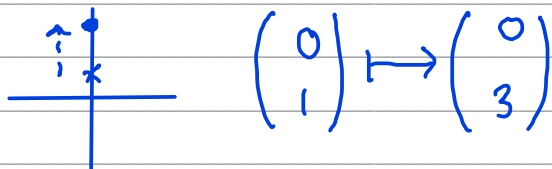
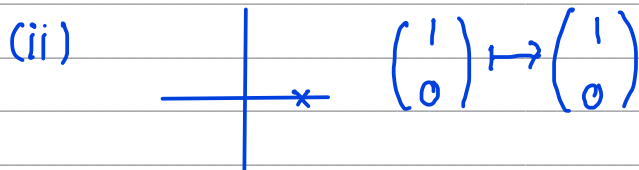
a) (i)



consider what happens to the two unit vectors



Rotation 90° anticlockwise about the origin (1)



Stretch scale factor 3 parallel to y-axis (1)



Question 1 continued

$$b) R = QP = \begin{pmatrix} 1 & 0 \\ 0 & 3 \end{pmatrix} \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} = \begin{pmatrix} 1 \times 0 + 0 \times 1 & 1 \times -1 + 0 \times 0 \\ 0 \times 0 + 3 \times 1 & 0 \times -1 + 3 \times 0 \end{pmatrix}$$

$$= \begin{pmatrix} 0 & -1 \\ 3 & 0 \end{pmatrix} \text{ ①}$$

$$c) (i) \det R = 0 \times 0 - (-1) \times 3$$

$$= 3 \text{ ①}$$

(ii) the area scale factor of the transformation. ①
 the transformed shape has 3 times the area
 as the original shape.

(Total for Question 1 is 7 marks)



2. The cubic equation

$$9x^3 - 5x^2 + 4x + 7 = 0$$

has roots α , β and γ .

Without solving the equation, find the cubic equation whose roots are $(3\alpha - 2)$, $(3\beta - 2)$ and $(3\gamma - 2)$, giving your answer in the form $aw^3 + bw^2 + cw + d = 0$, where a , b , c and d are integers to be determined.

(5)

new roots are solutions to $w = 3x - 2$

$$\Rightarrow x = \frac{w+2}{3} \quad (1)$$

$$9\left(\frac{w+2}{3}\right)^3 - 5\left(\frac{w+2}{3}\right)^2 + 4\left(\frac{w+2}{3}\right) + 7 = 0 \quad (1)$$

$$\frac{1}{3}(w^3 + 6w^2 + 12w + 8) - \frac{5}{9}(w^2 + 4w + 4) + \frac{4}{3}(w + 2) + 7 = 0$$

$$\frac{1}{3}w^3 + 2w^2 + 4w + \frac{8}{3} - \frac{5}{9}w^2 - \frac{20}{9}w - \frac{20}{9} + \frac{4}{3}w + \frac{8}{3} + 7 = 0$$

$$\frac{1}{3}w^3 + \frac{13}{9}w^2 + \frac{28}{9}w + \frac{91}{9} = 0 \quad (1)$$

$$3w^3 + 13w^2 + 28w + 91 = 0$$

(1) (1)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



Question 2 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(Total for Question 2 is 5 marks)



3. (a) Use the standard results for summations to show that for all positive integers n

$$\sum_{r=1}^n (5r-2)^2 = \frac{1}{6}n(an^2 + bn + c)$$

where a , b and c are integers to be determined.

(5)

- (b) Hence determine the value of k for which

$$\sum_{r=1}^k (5r-2)^2 = 94k^2$$

(4)

a) $(5r-2)^2 = 25r^2 - 20r + 4$ ①

$$\sum_{r=1}^n (5r-2)^2 = \sum_{r=1}^n 25r^2 - 20r + 4$$

split up the summations

$$= 25 \sum_{r=1}^n r^2 - 20 \sum_{r=1}^n r + 4 \sum_{r=1}^n 1$$

$$= \frac{25}{6} n(n+1)(2n+1) - \frac{20}{2} n(n+1) + 4n$$

use standard results

$$= \frac{1}{6} n [25(n+1)(2n+1) - 60(n+1) + 24] \text{ ①}$$

$$= \frac{1}{6} n [50n^2 + 75n + 25 - 60n - 60 + 24]$$

$$= \frac{1}{6} n [50n^2 + 15n - 11] \text{ ①}$$

b) $\frac{1}{6} k [50k^2 + 15k - 11] = 94k^2$ ①

$$50k^3 + 15k^2 - 11k = 564k^2$$



Question 3 continued

$$50k^3 - 549k^2 - 11k = 0 \quad (1)$$

$$k(k-11)(50k+1) = 0 \quad (1)$$

$$k=0, k=11 \text{ or } k=-1/50$$

choose $k=11$ as k is a positive integer greater than 1. (1)

(Total for Question 3 is 9 marks)



$$4. \quad \mathbf{M} = \begin{pmatrix} 2 & 1 & 4 \\ k & 2 & -2 \\ 4 & 1 & -2 \end{pmatrix} \quad \mathbf{N} = \begin{pmatrix} k-7 & 6 & -10 \\ 2 & -20 & 24 \\ -3 & 2 & -1 \end{pmatrix}$$

where k is a constant.

(a) Determine, in simplest form in terms of k , the matrix \mathbf{MN} .

(2)

(b) Given that $k = 5$

(i) write down \mathbf{MN}

(ii) hence write down \mathbf{M}^{-1}

(2)

(c) Solve the simultaneous equations

$$\begin{aligned} 2x + y + 4z &= 2 \\ 5x + 2y - 2z &= 3 \\ 4x + y - 2z &= -1 \end{aligned}$$

(2)

(d) Interpret the answer to part (c) geometrically.

(1)

$$a) \mathbf{MN} = \begin{pmatrix} 2 & 1 & 4 \\ k & 2 & -2 \\ 4 & 1 & -2 \end{pmatrix} \begin{pmatrix} k-7 & 6 & -10 \\ 2 & -20 & 24 \\ -3 & 2 & -1 \end{pmatrix}$$

$$= \begin{pmatrix} 2(k-7) + 2 - 12 & 12 - 20 + 8 & -20 + 24 - 4 \\ k(k-7) + 4 + 6 & 6k - 40 - 4 & -10k + 48 + 2 \\ 4(k-7) + 2 + 6 & 24 - 20 - 2 & -40 + 24 + 2 \end{pmatrix} \quad \textcircled{1}$$

$$= \begin{pmatrix} 2k - 24 & 0 & 0 \\ k^2 - 7k + 10 & 6k - 44 & -10k + 50 \\ 4k - 20 & 0 & -14 \end{pmatrix} \quad \textcircled{1}$$



Question 4 continued

$$b) \quad (i) \quad k=5 \Rightarrow MN = \begin{pmatrix} -14 & 0 & 0 \\ 0 & -14 & 0 \\ 0 & 0 & -14 \end{pmatrix} \quad (1)$$

$$(ii) \quad MN = -14I$$

$$M^{-1}MN = -14M^{-1}I$$

$$-14M^{-1} = N$$

$$M^{-1} = -\frac{1}{14}N$$

$$M^{-1} = -\frac{1}{14} \begin{pmatrix} -2 & 6 & -10 \\ 2 & -20 & 24 \\ -3 & 2 & -1 \end{pmatrix} \quad (1)$$

$$c) \quad M \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 2 \\ 3 \\ -1 \end{pmatrix}$$

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = -\frac{1}{14} \begin{pmatrix} -2 & 6 & -10 \\ 2 & -20 & 24 \\ -3 & 2 & -1 \end{pmatrix} \begin{pmatrix} 2 \\ 3 \\ -1 \end{pmatrix} \quad (1)$$

$$= \begin{pmatrix} -12/7 \\ 40/7 \\ -1/14 \end{pmatrix}$$

$$x = -\frac{12}{7} \quad y = \frac{40}{7} \quad z = -\frac{1}{14} \quad (1)$$

d) the coordinates of the only point at which the planes represented by the equations in (c) meet. (1)



5.

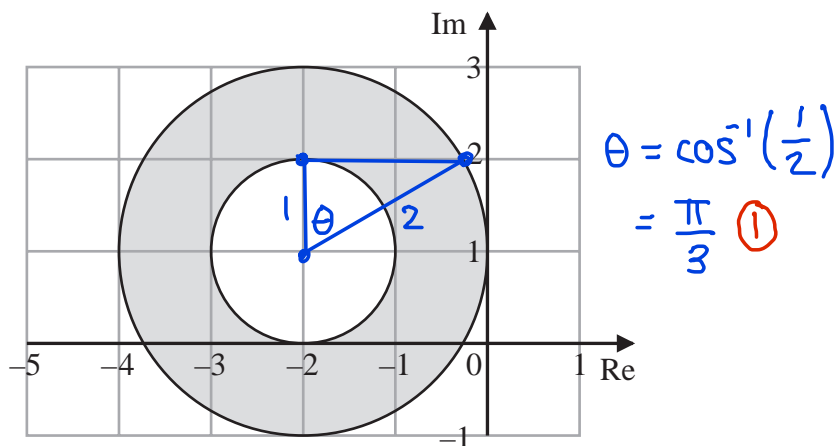


Figure 1

Figure 1 shows an Argand diagram.

The set P , of points that lie within the shaded region including its boundaries, is defined by

$$P = \{z \in \mathbb{C} : a \leq |z + b + ci| \leq d\}$$

where a, b, c and d are integers.

(a) Write down the values of a, b, c and d .

(3)

The set Q is defined by

$$Q = \{z \in \mathbb{C} : a \leq |z + b + ci| \leq d\} \cap \{z \in \mathbb{C} : |z - i| \leq |z - 3i|\}$$

(b) Determine the exact area of the region defined by Q , giving your answer in simplest form.

(7)

a) $a \leq |z - (-b - ci)| \leq d$

i.e. the radius of the circle centre $(-b, -c)$ is between a and d .

centre $(-2, 1) = (-b, -c) \Rightarrow b = 2 \quad c = -1$

$a = 1, d = 2$

b) area Q is area P with $|z - (0 + i)| \leq |z - (0 + 3i)|$

i.e. closer to $(0, 1)$ than $(0, 3) \Rightarrow y \leq 2$

DO NOT WRITE IN THIS AREA

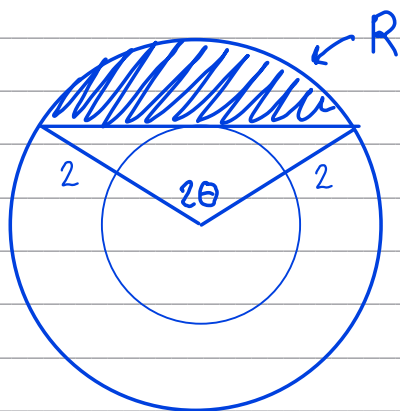
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



Question 5 continued

$$\text{total area } P = \pi \times 2^2 - \pi \times 1^2 = 3\pi \quad \textcircled{1}$$



$$Q = P - \text{shaded area } R$$

$$R = \text{sector} - \text{triangle}$$

$$= \frac{1}{2} \times \frac{2\pi}{3} \times 2^2 - \frac{1}{2} \times 2 \times 2 \times \sin \frac{2\pi}{3} \quad \textcircled{1}$$

$$= \frac{4\pi}{3} - \sqrt{3} \quad \textcircled{1}$$

area of a sector
 $= \frac{1}{2} r^2 \theta$

area of a triangle
 $= \frac{1}{2} ab \sin C$

$$Q = 3\pi - \left(\frac{4\pi}{3} - \sqrt{3} \right)$$

$$Q = \frac{5\pi}{3} + \sqrt{3} \quad \textcircled{1}$$



6. A mining company has identified a mineral layer below ground.

The mining company wishes to drill down to reach the mineral layer and models the situation as follows.

With respect to a fixed origin O ,

- the ground is modelled as a horizontal plane with equation $z = 0$
- the mineral layer is modelled as part of the plane containing the points $A(10, 5, -50)$, $B(15, 30, -45)$ and $C(-5, 20, -60)$, where the units are in metres

(a) Determine an equation for the plane containing A , B and C , giving your answer in the form $\mathbf{r} \cdot \mathbf{n} = d$ (5)

(b) Determine, according to the model, the acute angle between the ground and the plane containing the mineral layer. Give your answer to the nearest degree. (3)

The mining company plans to drill vertically downwards from the point $(5, 12, 0)$ on the ground to reach the mineral layer.

(c) Using the model, determine, in metres to 1 decimal place, the distance the mining company will need to drill in order to reach the mineral layer. (2)

(d) State a limitation of the assumption that the mineral layer can be modelled as a plane. (1)

$$a) \quad \vec{AB} = \begin{pmatrix} 15 \\ 30 \\ -45 \end{pmatrix} - \begin{pmatrix} 10 \\ 5 \\ -50 \end{pmatrix} = \begin{pmatrix} 5 \\ 25 \\ 5 \end{pmatrix}$$

$$\vec{AC} = \begin{pmatrix} -5 \\ 20 \\ -60 \end{pmatrix} - \begin{pmatrix} 10 \\ 5 \\ -50 \end{pmatrix} = \begin{pmatrix} -15 \\ 15 \\ -10 \end{pmatrix} \quad \textcircled{1}$$

normal vector \underline{n} is perpendicular to \vec{AB} and \vec{AC}

$$\text{let } \underline{n} = \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} \cdot \begin{pmatrix} 5 \\ 25 \\ 5 \end{pmatrix} = 0 \Rightarrow 5x + 25y + 5z = 0$$

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} \cdot \begin{pmatrix} -15 \\ 15 \\ -10 \end{pmatrix} = 0 \Rightarrow -15x + 15y - 10z = 0 \quad \textcircled{1}$$



Question 6 continued

choose $z = 1$: $5x + 25y = -5$

$$-15x + 15y = 10$$

solve for x and y : $x = -\frac{13}{18}$, $y = -\frac{1}{18}$

\underline{n} is parallel to $\begin{pmatrix} -13/18 \\ -1/18 \\ 1 \end{pmatrix}$ or $\begin{pmatrix} -13 \\ -1 \\ 18 \end{pmatrix}$ ①

$d = \underline{n} \cdot \underline{a}$, \underline{a} is a point on the plane

$$d = \begin{pmatrix} -13 \\ -1 \\ 18 \end{pmatrix} \cdot \begin{pmatrix} 10 \\ 5 \\ -50 \end{pmatrix} = -1035$$
 ①

\therefore plane: $r \cdot \begin{pmatrix} -13 \\ -1 \\ 18 \end{pmatrix} = -1035$ ①

b) acute angle between two planes:

$$\cos \theta = \frac{|\underline{n}_1 \cdot \underline{n}_2|}{|\underline{n}_1| |\underline{n}_2|}$$

where \underline{n}_1 and \underline{n}_2 are the normals of the planes

$$\underline{n}_1 = \begin{pmatrix} -13 \\ -1 \\ 18 \end{pmatrix} \quad \underline{n}_2 = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$$

$$\begin{pmatrix} -13 \\ -1 \\ 18 \end{pmatrix} \cdot \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} = 18$$
 ① $|\underline{n}_1| = \sqrt{13^2 + 1^2 + 18^2} = \sqrt{494}$ ①



Question 6 continued

$$\cos\theta = \frac{18}{\sqrt{494}} \Rightarrow \theta = 35.917\dots$$

$$\theta = 36^\circ \text{ (nearest degree) } \textcircled{1}$$

c) shortest distance vertically downwards
from $\begin{pmatrix} 5 \\ 12 \\ 0 \end{pmatrix}$ to the plane is $|\lambda|$ where

$$\begin{pmatrix} -13 \\ -1 \\ 18 \end{pmatrix} \cdot \begin{pmatrix} 5 \\ 12 \\ \lambda \end{pmatrix} = -1035 \textcircled{1}$$

$$-65 - 12 + 18\lambda = -1035$$

$$18\lambda = -958$$

$$\lambda = -53.22\dots$$

shortest distance is 53.2m (1dp) $\textcircled{1}$

d) the mineral layer will not be perfectly smooth
so it won't be a plane $\textcircled{1}$

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



Question 6 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(Total for Question 6 is 11 marks)



P 6 6 7 9 0 A 0 1 9 3 2

7.

$$f(z) = z^4 - 6z^3 + pz^2 + qz + r$$

where p , q and r are real constants.

The roots of the equation $f(z) = 0$ are α , β , γ and δ where $\alpha = 3$ and $\beta = 2 + i$

Given that γ is a complex root of $f(z) = 0$

- (a) (i) write down the root γ ,
(ii) explain why δ must be real. (2)
- (b) Determine the value of δ . (2)
- (c) Hence determine the values of p , q and r . (3)
- (d) Write down the roots of the equation $f(-2z) = 0$ (2)

a) (i) γ is the complex conjugate of β , so $\gamma = 2 - i$ ①

(ii) δ is real because complex roots of polynomials (with real coefficients) come in conjugate pairs. β and γ form a conjugate pair, α is real so δ must also be real. ①

b) $\sum \alpha = \frac{-b}{a} = 6$

$$\alpha + \beta + \gamma + \delta = 6$$

$$3 + 2 + i + 2 - i + \delta = 6 \quad \text{①}$$

$$\delta = -1 \quad \text{①}$$

c)	$\alpha = 3$	$\alpha + \delta = 2$	$\beta = 2 + i$	$\gamma + \beta = 4$
	$\delta = -1$	$\alpha \delta = -3$	$\gamma = 2 - i$	$\gamma \beta = 5$

$$\Rightarrow z^2 - 2z - 3 = 0 \quad \Rightarrow z^2 - 4z + 5 = 0$$

$$f(z) = (z^2 - 2z - 3)(z^2 - 4z + 5) \quad \text{①}$$

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



Question 7 continued

$$f(z) = (z^2 - 2z - 3)(z^2 - 4z + 5)$$

$$= z^4 - 4z^3 + 5z^2 - 2z^3 + 8z^2 - 10z - 3z^2 + 12z - 15$$

$$= z^4 - 6z^3 + 10z^2 + 2z - 15$$

$$p=10 \quad q=2 \quad r=-15 \quad \textcircled{2}$$

$$d) \quad -2z = 3 \Rightarrow z = -\frac{3}{2}$$

$$-2z = -1 \Rightarrow z = \frac{1}{2} \quad \textcircled{1}$$

$$-2z = 2 \pm i \Rightarrow z = -1 \pm \frac{1}{2}i \quad \textcircled{1}$$



8. (a) Prove by induction that, for all positive integers n ,

$$\sum_{r=1}^n r(r+1)(2r+1) = \frac{1}{2}n(n+1)^2(n+2) \quad (6)$$

- (b) Hence, show that, for all positive integers n ,

$$\sum_{r=n}^{2n} r(r+1)(2r+1) = \frac{1}{2}n(n+1)(an+b)(cn+d)$$

where a, b, c and d are integers to be determined.

(3)

a) • Base case $n=1$

$$\text{LHS: } \sum_{r=1}^1 r(r+1)(2r+1) = (1)(2)(3) = 6$$

$$\text{RHS: } \frac{1}{2}(1)(2)^2(3) = 6$$

$$\text{LHS} = \text{RHS} \therefore \text{true for } n=1 \quad (1)$$

- Assume true for $n=k$:

$$\sum_{r=1}^k r(r+1)(2r+1) = \frac{1}{2}k(k+1)^2(k+2) \quad (1)$$

- for $n=k+1$:

$$\sum_{r=1}^{k+1} r(r+1)(2r+1) = \sum_{r=1}^k r(r+1)(2r+1) + (k+1)(k+2)(2k+3) \quad (1)$$

$$= \frac{1}{2}k(k+1)^2(k+2) + (k+1)(k+2)(2k+3)$$

$$= \frac{1}{2}(k+1)(k+2)[k(k+1) + 2(2k+3)] \quad (1)$$

$$= \frac{1}{2}(k+1)(k+2)[k^2 + 5k + 6]$$

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



Question 8 continued

$$= \frac{1}{2} (k+1)(k+2)(k+2)(k+3)$$

$$= \frac{1}{2} (k+1)((k+1)+1)^2((k+1)+2)$$

which is true for $n=k+1$ ①

- If true for $n=k$, then shown true for $n=k+1$. As true for $n=1$, true for all positive integers n . ①

$$b) \sum_{r=n}^{2n} = \sum_{r=0}^{2n} - \sum_{r=0}^{n-1}$$

$$= \frac{1}{2} (2n)(2n+1)^2(2n+2) - \frac{1}{2} (n-1)n^2(n+1) \quad \text{①}$$

$$= \frac{1}{2} n(n+1) [4(2n+1)^2 - n(n-1)] \quad \text{①}$$

$$= \frac{1}{2} n(n+1) [4(4n^2 + 4n + 1) - n^2 + n]$$

$$= \frac{1}{2} n(n+1) [15n^2 + 17n + 4]$$

$$= \frac{1}{2} n(n+1)(3n+1)(5n+4) \quad \text{①}$$



Question 8 continued

Lined writing area with multiple horizontal lines for student response.

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



9.

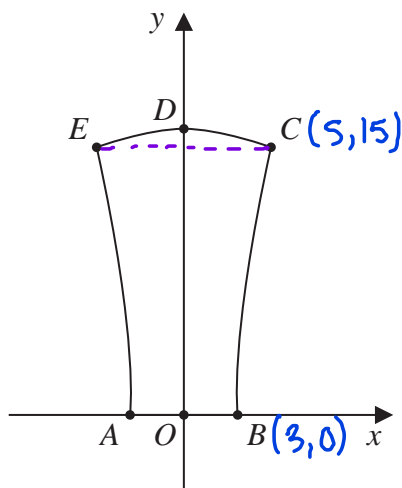


Figure 2

Figure 2 shows the vertical cross-section, $AOBCE$, through the centre of a wax candle.

In a model, the candle is formed by rotating the region bounded by the y -axis, the line OB , the curve BC , and the curve CD through 360° about the y -axis.

The point B has coordinates $(3, 0)$ and the point C has coordinates $(5, 15)$.

The units are in centimetres.

The curve BC is represented by the equation

$$y = \frac{\sqrt{225x^2 - 2025}}{a} \quad 3 \leq x < 5$$

where a is a constant.

(a) Determine the value of a according to this model.

(2)

The curve CD is represented by the equation

$$y = 16 - 0.04x^2 \quad 0 \leq x < 5$$

(b) Using algebraic integration, determine, according to the model, the exact volume of wax that would be required to make the candle.

(9)

(c) State a limitation of the model.

(1)

When the candle was manufactured, 700 cm^3 of wax were required.

(d) Use this information and your answer to part (b) to evaluate the model, explaining your reasoning.

(1)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



Question 9 continued

a) from C: when $x = 5$, $y = 15$

$$15 = \frac{\sqrt{225(5)^2 - 2025}}{a} \quad (1)$$

$$15a = 60$$

$$a = 4 \quad (1)$$

b) rearranging curve BC making x^2 the subject:

$$y = \frac{\sqrt{225x^2 - 2025}}{4}$$

$$16y^2 = 225x^2 - 2025$$

$$x^2 = \frac{1}{225}(16y^2 + 2025)$$

rearranging curve CD making x^2 the subject:

$$y = 16 - 0.04x^2$$

$$x^2 = 400 - 25y = 25(16 - y)$$

finding where CD cuts y-axis: set $x = 0$, $y = 16$

$$\text{Volume} = \frac{\pi}{225} \int_0^{15} (16y^2 + 2025) dy + 25\pi \int_{15}^{16} (16 - y) dy \quad (1)$$

$$= \frac{\pi}{225} \left[\frac{16y^3}{3} + 2025y \right]_0^{15} + 25\pi \left[16y - \frac{y^2}{2} \right]_{15}^{16} \quad (1)$$



Question 9 continued

$$= \frac{\pi}{225} (18,000 + 30375) + 25\pi \left(128 - \frac{255}{2}\right) \textcircled{1}$$

$$= 215\pi + 12.5\pi$$

$$= 227.5\pi \textcircled{1}$$

c) the sides of the candle may not be perfectly smooth $\textcircled{1}$

d) The model gives the volume as 715cm^3 which is a good estimate as 700cm^3 is only 15cm^3 smaller. $\textcircled{1}$

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



Question 9 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

A large rectangular area containing horizontal lines for writing answers, starting below the title and ending above the footer.



P 6 6 7 9 0 A 0 3 1 3 2

Question 9 continued

Lined area for writing answers, consisting of approximately 28 horizontal lines.

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(Total for Question 9 is 13 marks)

TOTAL FOR CORE PURE MATHEMATICS IS 80 MARKS

