

Leave blank

Question 1 continued

Ruled area for writing answers, consisting of approximately 25 horizontal lines.

(Total 4 marks)

Q1



Leave
blank

Question 2 continued

Ruled area for writing the answer to Question 2.

(Total 6 marks)

Q2



3.

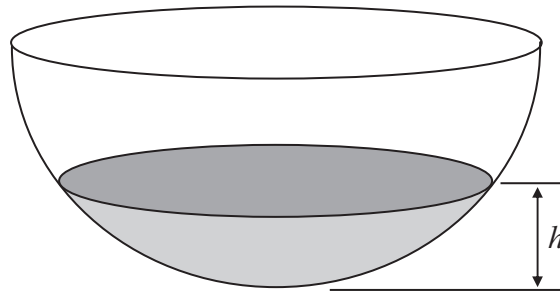


Figure 1

A hollow hemispherical bowl is shown in Figure 1. Water is flowing into the bowl. When the depth of the water is h m, the volume V m³ is given by

$$V = \frac{1}{12} \pi h^2 (3 - 4h), \quad 0 \leq h \leq 0.25$$

(a) Find, in terms of π , $\frac{dV}{dh}$ when $h = 0.1$ (4)

Water flows into the bowl at a rate of $\frac{\pi}{800}$ m³s⁻¹.

(b) Find the rate of change of h , in m s⁻¹, when $h = 0.1$ (2)



Leave
blank

Question 3 continued

Lined area for writing the answer to Question 3.

(Total 6 marks)

Q3



P 3 8 1 6 0 A 0 7 2 4

4.

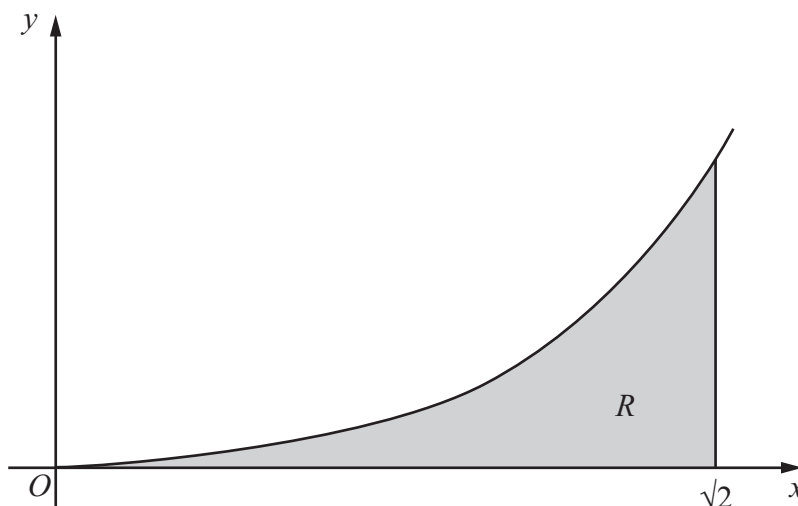


Figure 2

Figure 2 shows a sketch of the curve with equation $y = x^3 \ln(x^2 + 2)$, $x \geq 0$. The finite region R , shown shaded in Figure 2, is bounded by the curve, the x -axis and the line $x = \sqrt{2}$.

The table below shows corresponding values of x and y for $y = x^3 \ln(x^2 + 2)$.

x	0	$\frac{\sqrt{2}}{4}$	$\frac{\sqrt{2}}{2}$	$\frac{3\sqrt{2}}{4}$	$\sqrt{2}$
y	0		0.3240		3.9210

(a) Complete the table above giving the missing values of y to 4 decimal places. (2)

(b) Use the trapezium rule, with all the values of y in the completed table, to obtain an estimate for the area of R , giving your answer to 2 decimal places. (3)

(c) Use the substitution $u = x^2 + 2$ to show that the area of R is

$$\frac{1}{2} \int_2^4 (u - 2) \ln u \, du \quad (4)$$

(d) Hence, or otherwise, find the exact area of R . (6)



Leave
blank

Question 4 continued

Lined writing area for the answer to Question 4.



Leave
blank

Question 4 continued

Area for writing the answer to Question 4 continued, consisting of horizontal lines.



Leave
blank

Question 4 continued

Lined area for writing answers to Question 4.

(Total 15 marks)

Q4

--	--



P 3 8 1 6 0 A 0 1 1 2 4

6. With respect to a fixed origin O , the lines l_1 and l_2 are given by the equations

$$l_1: \mathbf{r} = \begin{pmatrix} 6 \\ -3 \\ -2 \end{pmatrix} + \lambda \begin{pmatrix} -1 \\ 2 \\ 3 \end{pmatrix}, \quad l_2: \mathbf{r} = \begin{pmatrix} -5 \\ 15 \\ 3 \end{pmatrix} + \mu \begin{pmatrix} 2 \\ -3 \\ 1 \end{pmatrix},$$

where λ and μ are scalar parameters.

(a) Show that l_1 and l_2 meet and find the position vector of their point of intersection A . (6)

(b) Find, to the nearest 0.1° , the acute angle between l_1 and l_2 . (3)

The point B has position vector $\begin{pmatrix} 5 \\ -1 \\ 1 \end{pmatrix}$.

(c) Show that B lies on l_1 . (1)

(d) Find the shortest distance from B to the line l_2 , giving your answer to 3 significant figures. (4)



Leave
blank

Question 6 continued

Blank lined area for writing answers.

Q6

--	--

(Total 14 marks)



Leave blank

7.

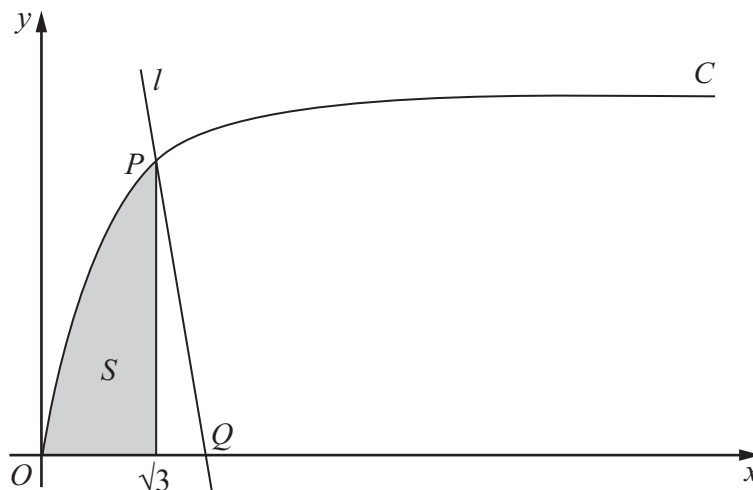


Figure 3

Figure 3 shows part of the curve C with parametric equations

$$x = \tan \theta, \quad y = \sin \theta, \quad 0 \leq \theta < \frac{\pi}{2}$$

The point P lies on C and has coordinates $\left(\sqrt{3}, \frac{1}{2}\sqrt{3}\right)$.

(a) Find the value of θ at the point P . (2)

The line l is a normal to C at P . The normal cuts the x -axis at the point Q .

(b) Show that Q has coordinates $(k\sqrt{3}, 0)$, giving the value of the constant k . (6)

The finite shaded region S shown in Figure 3 is bounded by the curve C , the line $x = \sqrt{3}$ and the x -axis. This shaded region is rotated through 2π radians about the x -axis to form a solid of revolution.

(c) Find the volume of the solid of revolution, giving your answer in the form $p\pi\sqrt{3} + q\pi^2$, where p and q are constants. (7)



Leave blank

Question 7 continued

Lined area for writing the answer to Question 7.



Leave blank

8. (a) Find $\int (4y+3)^{-\frac{1}{2}} dy$ (2)

(b) Given that $y = 1.5$ at $x = -2$, solve the differential equation

$$\frac{dy}{dx} = \frac{\sqrt{4y+3}}{x^2}$$

giving your answer in the form $y = f(x)$. (6)



