



1. The curve  $C$  has the equation  $2x + 3y^2 + 3x^2y = 4x^2$ .

The point  $P$  on the curve has coordinates  $(-1, 1)$ .

(a) Find the gradient of the curve at  $P$ .

(5)

(b) Hence find the equation of the normal to  $C$  at  $P$ , giving your answer in the form  $ax+by+c = 0$ , where  $a, b$  and  $c$  are integers.

(3)

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---



**Question 1 continued**

Lined area for writing the answer to Question 1.

**(Total 8 marks)**

**Q1**







3. (a) Expand

$$\frac{1}{(2-5x)^2}, \quad |x| < \frac{2}{5}$$

in ascending powers of  $x$ , up to and including the term in  $x^2$ , giving each term as a simplified fraction.

(5)

Given that the binomial expansion of  $\frac{2+kx}{(2-5x)^2}, \quad |x| < \frac{2}{5}$ , is

$$\frac{1}{2} + \frac{7}{4}x + Ax^2 + \dots$$

(b) find the value of the constant  $k$ ,

(2)

(c) find the value of the constant  $A$ .

(2)

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---



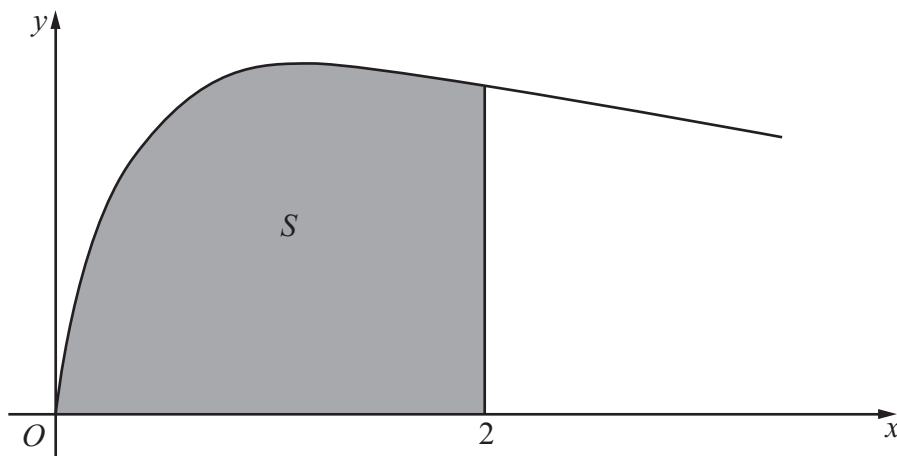








4.



**Figure 1**

Figure 1 shows the curve with equation

$$y = \sqrt{\left(\frac{2x}{3x^2 + 4}\right)}, \quad x \geq 0$$

The finite region  $S$ , shown shaded in Figure 1, is bounded by the curve, the  $x$ -axis and the line  $x = 2$

The region  $S$  is rotated  $360^\circ$  about the  $x$ -axis.

Use integration to find the exact value of the volume of the solid generated, giving your answer in the form  $k \ln a$ , where  $k$  and  $a$  are constants.

**(5)**

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---



5.

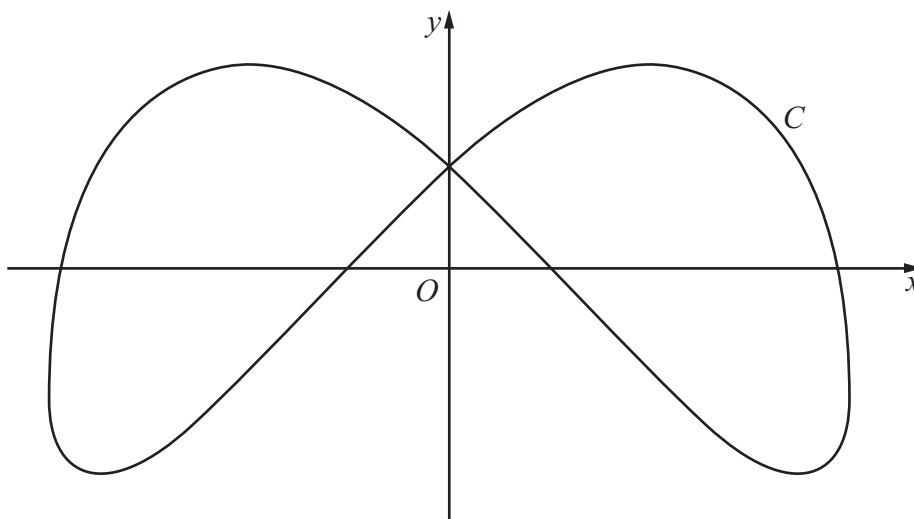


Figure 2

Figure 2 shows a sketch of the curve  $C$  with parametric equations

$$x = 4 \sin \left( t + \frac{\pi}{6} \right), \quad y = 3 \cos 2t, \quad 0 \leq t < 2\pi$$

(a) Find an expression for  $\frac{dy}{dx}$  in terms of  $t$ . (3)

(b) Find the coordinates of all the points on  $C$  where  $\frac{dy}{dx} = 0$ . (5)

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---







**Question 5 continued**

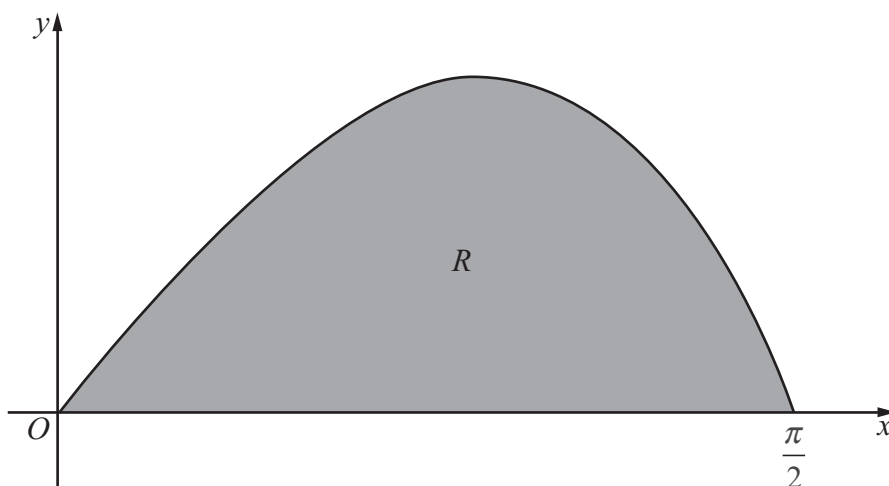
Handwriting lines for question 5

Q5

**(Total 8 marks)**



6.



**Figure 3**

Figure 3 shows a sketch of the curve with equation  $y = \frac{2 \sin 2x}{(1 + \cos x)}$ ,  $0 \leq x \leq \frac{\pi}{2}$ .

The finite region  $R$ , shown shaded in Figure 3, is bounded by the curve and the  $x$ -axis.

The table below shows corresponding values of  $x$  and  $y$  for  $y = \frac{2 \sin 2x}{(1 + \cos x)}$ .

$x$	0	$\frac{\pi}{8}$	$\frac{\pi}{4}$	$\frac{3\pi}{8}$	$\frac{\pi}{2}$
$y$	0		1.17157	1.02280	0

(a) Complete the table above giving the missing value of  $y$  to 5 decimal places. (1)

(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 4 decimal places. (3)

(c) Using the substitution  $u = 1 + \cos x$ , or otherwise, show that

$$\int \frac{2 \sin 2x}{(1 + \cos x)} dx = 4 \ln(1 + \cos x) - 4 \cos x + k$$

where  $k$  is a constant. (5)

(d) Hence calculate the error of the estimate in part (b), giving your answer to 2 significant figures. (3)











7. Relative to a fixed origin  $O$ , the point  $A$  has position vector  $(2\mathbf{i} - \mathbf{j} + 5\mathbf{k})$ , the point  $B$  has position vector  $(5\mathbf{i} + 2\mathbf{j} + 10\mathbf{k})$ , and the point  $D$  has position vector  $(-\mathbf{i} + \mathbf{j} + 4\mathbf{k})$ .

The line  $l$  passes through the points  $A$  and  $B$ .

- (a) Find the vector  $\overrightarrow{AB}$ . (2)
- (b) Find a vector equation for the line  $l$ . (2)
- (c) Show that the size of the angle  $BAD$  is  $109^\circ$ , to the nearest degree. (4)

The points  $A$ ,  $B$  and  $D$ , together with a point  $C$ , are the vertices of the parallelogram  $ABCD$ , where  $\overrightarrow{AB} = \overrightarrow{DC}$ .

- (d) Find the position vector of  $C$ . (2)
- (e) Find the area of the parallelogram  $ABCD$ , giving your answer to 3 significant figures. (3)
- (f) Find the shortest distance from the point  $D$  to the line  $l$ , giving your answer to 3 significant figures. (2)

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---







**Question 7 continued**

Lined area for writing the answer to Question 7.

**Q7**

**(Total 15 marks)**

--	--



8. (a) Express  $\frac{1}{P(5-P)}$  in partial fractions. **(3)**

A team of conservationists is studying the population of meerkats on a nature reserve. The population is modelled by the differential equation

$$\frac{dP}{dt} = \frac{1}{15}P(5 - P), \quad t \geq 0$$

where  $P$ , in thousands, is the population of meerkats and  $t$  is the time measured in years since the study began.

Given that when  $t = 0$ ,  $P = 1$ ,

- (b) solve the differential equation, giving your answer in the form,

$$P = \frac{a}{b + ce^{-\frac{1}{3}t}}$$

where  $a$ ,  $b$  and  $c$  are integers. **(8)**

- (c) Hence show that the population cannot exceed 5000 **(1)**

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---









Question 8 continued

Lined area for writing answers to Question 8.



Leave  
blank

**Question 8 continued**

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

**(Total 12 marks)**

**Q8**

**TOTAL FOR PAPER: 75 MARKS**

**END**

