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Pearson Edexcel IAL Pure Mathematics 1 (WMA11/01), October 2022

One real student's handwritten script, 28 pages. Name and candidate details removed.

Marked against Pearson's official mark scheme with the same instructions given to all eight examiners.

Whole paper: 46/75

By question

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How to read it: every part has its mark, the examiner's reason, and for lost marks the concept to fix.

This is sample marking for practice and mocks, not official Pearson marking.

In normal use, the student's teacher approves every mark before it is released.

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Cover page. Marking starts on page 2.

Please check the examination details below before entering your candidate information

Candidate details removed

Pearson Edexcel International Advanced Level

Time 1 hour 30 minutes

Paper reference **WMA11/01**

Mathematics

International Advanced Subsidiary/Advanced Level
Pure Mathematics P1

You must have:
Mathematical Formulae and Statistical Tables (Yellow), calculator

Total Marks

Candidates may use any calculator permitted 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 75.
- 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.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

Turn over ▶

P72137A

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B:1/1/1/1/

P 7 2 1 3 7 A 0 1 2 8

Pearson

1. The curve C has equation

$$y = \frac{x^3}{4} - x^2 + \frac{17}{x} \qquad x > 0$$

(a) Find $\frac{dy}{dx}$, giving your answer in simplest form.

(3)

The point $R\left(2, \frac{13}{2}\right)$ lies on C.

(b) Find the equation of the tangent to C at the point R. Write your answer in the form $ax + by + c = 0$, where a, b and c are integers to be found.

(3)

a) $\frac{3x^2}{4} - 2x - \frac{17}{x^2}$

b) $m = \frac{2^3}{4} - 2^2 + \frac{17}{2} = \frac{13}{2}$

$y - y_1 = m(x - x_1)$

$y - \frac{13}{2} = \frac{13}{2}(x - 2)$

$y - \frac{13}{2} = \frac{13}{2}x - 13$

$y = \frac{13}{2}x - \frac{13}{2}$

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Question 1 **3/6**

1(a) 3/3

Correctly differentiated the expression.

1(b) 0/3

The student substituted x=2 into the original equation y instead of the derivative dy/dx, so no method marks can be awarded.

Fix: tangent needs dy/dx at the point, not y

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Question 1 continued

(Total for Question 1 is 6 marks)

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Question 1 (continued) 3/6

1(a) 3/3

Correctly differentiated the expression.

1(b) 0/3

The student substituted x=2 into the original equation y instead of the derivative dy/dx, so no method marks can be awarded.

Fix: tangent needs dy/dx at the point, not y

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2. Given that

$$(x-5)(2x+1)(x+3) \equiv ax^3 + bx^2 - 32x - 15$$

where a and b are constants,

(a) find the value of a and the value of b.

(2)

(b) Hence find

$$\int \frac{(x-5)(2x+1)(x+3)}{5\sqrt{x}}\,dx$$

writing each term in simplest form.

(5)

a) $(2x^2+x-10x-5)(x+3)$

$(2x^2-9x-5)(x+3)$

$2x^3-9x^2-5x+6x^2-27x-15$

$2x^3-3x^2-32x-15$

hence $a=2$

$b=-3$

b) $\frac{2x^3-3x^2-32x-15}{5\sqrt{x}}$

$\frac{2}{5}x^{2.5} - \frac{3}{5}x^{1.5} - 32x^{0.5} - \frac{3}{\sqrt{x}}$

$\frac{2x^{2.5+1}}{5(2.5+1)} - \frac{3x^{1.5+1}}{5(1.5+1)} - \frac{32x^{0.5+1}}{0.5+1} - 3\sqrt{x} + C$

$\frac{4}{35}x^{3.5} - \frac{6}{25}x^{2.5} - \frac{64}{3}x^{1.5} - 3\sqrt{x} + C$

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Question 2 **6/7**

2(a) 2/2

Correctly found constants a and b.

2(b) 4/5

Correctly expressed terms with indices and correctly integrated the first two terms (M1A1M1A1). The third and fourth terms had incorrect coefficients so the final A1 was withheld.

Fix: algebraic errors when simplifying coefficients of integrated terms

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Question 2 continued

(Total for Question 2 is 7 marks)

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Question 2 (continued) 6/7

2(a) 2/2

Correctly found constants a and b.

2(b) 4/5

Correctly expressed terms with indices and correctly integrated the first two terms (M1A1M1A1). The third and fourth terms had incorrect coefficients so the final A1 was withheld.

Fix: algebraic errors when simplifying coefficients of integrated terms

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3. The share price of a company is monitored.

Exactly 3 years after monitoring began, the share price was £1.05

Exactly 5 years after monitoring began, the share price was £1.65

The share price, £V, of the company is modelled by the equation

$$V = pt + q$$

where t is the number of years after monitoring began and p and q are constants.

(a) Find the value of p and the value of q.

(3)

Exactly T years after monitoring began, the share price was £2.50

(b) Find the value of T, according to the model, giving your answer to one decimal place.

(2)

a) $1.05 = p + q$

$1.05 = 3p + q$

$1.65 = 5p + q$

$1.05 - 3p = 1.65 - 5p$

$2p = 0.6$

$p = 0.3$

$q = 1.05 - 3(0.3) = \frac{3}{20}$

b) $2.5 = 0.3t + 0.15$

$\frac{2.5 - 0.15}{0.3} = t = \frac{47}{6}$

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Question 3 **4/5**

3(a) 3/3

Correctly formed simultaneous equations and found p and q.

3(b) 1/2

Correct method used to find T, but the final answer was not given to one decimal place as requested.

Fix: did not round final answer to requested accuracy

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Question 3 continued

(Total for Question 3 is 5 marks)

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Question 3 (continued) 4/5

3(a) 3/3

Correctly formed simultaneous equations and found p and q.

3(b) 1/2

Correct method used to find T, but the final answer was not given to one decimal place as requested.

Fix: did not round final answer to requested accuracy

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4. **In this question you must show detailed reasoning.**
Solutions relying on calculator technology are not acceptable.

$$f(x) = x^2(2x + 1) - 15x$$

(a) Solve

$$f(x) = 0$$

(4)

(b) Hence solve

$$y^{\frac{4}{3}}\left(2y^{\frac{2}{3}} + 1\right) - 15y^{\frac{2}{3}} = 0 \qquad y > 0$$

giving your answer in simplified surd form.

(2)

a) $x^2(2x+1) - 15x = 0$

$x(2x+1) = 15x$

$2x^2 + 2x - 15 = 0$

$\sqrt{b^2 - 4ac} = 2\sqrt{31}$

$\frac{-2 + 2\sqrt{31}}{2(2)} = 2.28, -3.28$

b) $y^{\frac{4}{3}}(2y^{\frac{2}{3}} + 1) = 15y^{\frac{2}{3}}$

$y^{\frac{2}{3}}(2y^{\frac{2}{3}} + 1) = 15$

$2y^{\frac{4}{3}} + y^{\frac{2}{3}} - 15$

$y^{\frac{2}{3}} = x$

$y^{\frac{2}{3}} = 2.28$

$y = \sqrt[\frac{2}{3}]{2.28}$

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Question 4 2/6

4(a) 2/4

Awarded M1 for cancelling an x to obtain a quadratic, and dM1 for attempting to solve their quadratic using the formula. B1 and A1 were lost because the expansion of x(2x+1) was incorrect (giving 2x^2 + 2x) and the root x=0 was lost.

Fix: algebraic error in expansion and lost a factor

4(b) 0/2

The student evaluated decimal approximations from part (a) instead of showing exact fractional exponents to get a simplified surd form.

Fix: used decimal approximations instead of exact fractional exponents

Question 4 continued

(Total for Question 4 is 6 marks)

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Question 4 (continued) 2/6

4(a) 2/4

Awarded M1 for cancelling an x to obtain a quadratic, and dM1 for attempting to solve their quadratic using the formula. B1 and A1 were lost because the expansion of x(2x+1) was incorrect (giving 2x^2 + 2x) and the root x=0 was lost.

Fix: algebraic error in expansion and lost a factor

4(b) 0/2

The student evaluated decimal approximations from part (a) instead of showing exact fractional exponents to get a simplified surd form.

Fix: used decimal approximations instead of exact fractional exponents

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5. **In this question you must show all stages of your working.**
Solutions relying entirely on calculator technology are not acceptable.

The curve C has equation $y = f(x), x > 0$

Given that

- $f'(x) = \frac{12}{\sqrt{x}} + \frac{x}{3} - 4$
- the point $P(9, 8)$ lies on C

(a) find, in simplest form, $f(x)$

(5)

The line l is the normal to C at P

(b) Find the coordinates of the point at which l crosses the y-axis.

(4)

a) $12x^{-0.5} + \frac{x}{3} - 4$

$\frac{12\sqrt{x}}{0.5} + \frac{x^2}{3(2)} - 4x + C$

$24\sqrt{x} + \frac{x^2}{6} - 4x + C = 8$

$24\sqrt{9} + \frac{9^2}{6} - 4(6) + C = 6$

$C = -\frac{107}{2}$

$24\sqrt{x} + \frac{x^2}{6} - 4x - \frac{107}{2}$

b) $12x^{-0.5} + \frac{x}{3} - 4 = m$

$12(9)^{-0.5} + \frac{9}{3} - 4 = m = 3$

$y - y_1 = m(x - x_1)$ → $y = 3x - 27 + 8$

$y - 8 = 3(x - 9)$ → $y = 3x - 19$

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Question 5 5/9

5(a) 4/5

Correct integration technique. However, when substituting x=9, the student accidentally substituted 6 into the -4x term, leading to an incorrect value for c.

Fix: substituted incorrect value into one term when finding constant of integration

5(b) 1/4

Awarded M1 for finding the tangent gradient at x=9. The remaining marks were withheld because the student found the equation of the tangent rather than the normal.

Fix: found the equation of the tangent instead of the normal

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Question 5 continued

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Sample script · whole paper 46/75

Question 5 (continued) 5/9

5(a) 4/5

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Question 5 continued

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Question 5 (continued) 5/9

5(a) 4/5

Correct integration technique. However, when substituting x=9, the student accidentally substituted 6 into the -4x term, leading to an incorrect value for c.

Fix: substituted incorrect value into one term when finding constant of integration

5(b) 1/4

Awarded M1 for finding the tangent gradient at x=9. The remaining marks were withheld because the student found the equation of the tangent rather than the normal.

Fix: found the equation of the tangent instead of the normal

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Question 5 continued

(Total for Question 5 is 9 marks)

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Question 5 (continued) 5/9

5(a) 4/5

Correct integration technique. However, when substituting x=9, the student accidentally substituted 6 into the -4x term, leading to an incorrect value for c.

Fix: substituted incorrect value into one term when finding constant of integration

5(b) 1/4

Awarded M1 for finding the tangent gradient at x=9. The remaining marks were withheld because the student found the equation of the tangent rather than the normal.

Fix: found the equation of the tangent instead of the normal

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6. (a) Given that k is a positive constant such that $0 < k < 4$ sketch, on **separate axes**, the graphs of

(i) $y = (2x - k)(x + 4)^2$

(ii) $y = \dfrac{k}{x^2}$

showing the coordinates of any points where the graphs cross or meet the coordinate axes, leaving coordinates in terms of k, where appropriate.

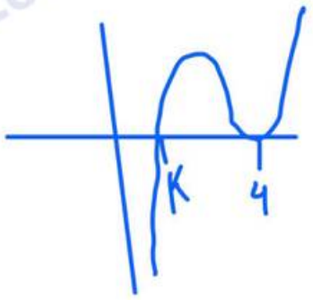
(5)

(b) State, with a reason, the number of roots of the equation

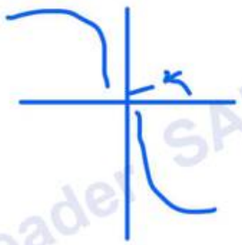
$$(2x - k)(x + 4)^2 = \frac{k}{x^2}$$

(1)

i)



ii)



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Question 6 — 3/6

6(a)(i) 1/3

Awarded 1 mark for sketching a positive cubic shape. The roots and turning points were placed incorrectly relative to the axes.

Fix: sketched the curve with the root and turning point on the wrong side of the y-axis

6(a)(i) 2/2

Correct sketch of the curve.

6(b) 0/1

Incorrectly stated there are no roots.

Fix: incorrectly interpreted intersection of graphs

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Question 6 continued

b)
No real roots as graphs do not intersect

(Total for Question 6 is 6 marks)

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Question 6 (continued) 3/6

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Awarded 1 mark for sketching a positive cubic shape. The roots and turning points were placed incorrectly relative to the axes.

Fix: sketched the curve with the root and turning point on the wrong side of the y-axis

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Correct sketch of the curve.

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Incorrectly stated there are no roots.

Fix: incorrectly interpreted intersection of graphs

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7.

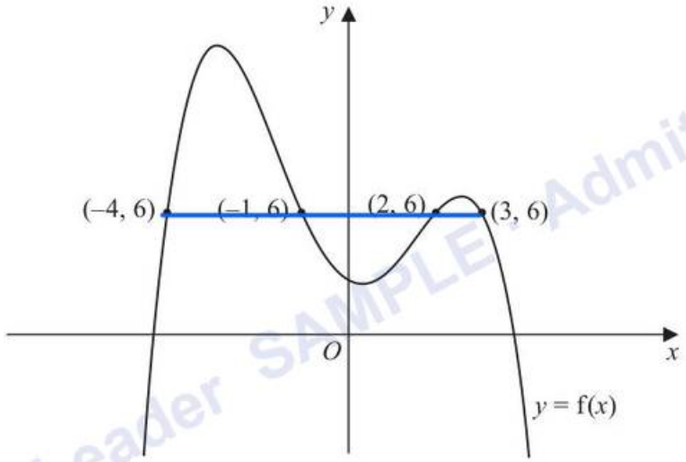


Figure 1

Figure 1 shows the curve with equation $y = f(x)$.

The points $P(-4, 6)$, $Q(-1, 6)$, $R(2, 6)$ and $S(3, 6)$ lie on the curve.

(a) Using Figure 1, find the range of values of x for which

$$f(x) < 6$$

(3)

(b) State the largest solution of the equation

$$f(2x) = 6$$

(1)

(c) (i) Sketch the curve with equation $y = f(-x)$.

On your sketch, state the coordinates of the points to which P, Q, R and S are transformed.

(ii) Hence find the set of values of x for which

$$f(-x) \geqslant 6 \text{ and } x < 0$$

(4)

a) below −4, between −1 and 2, above 3

b) 1.5 = x

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Question 7 — 4/8

7(a) 0/3

The question requires the inequalities to be written strictly in terms of x.

Fix: inequalities must be written mathematically in terms of x

7(b) 1/1

Correct answer.

7(c)(i) 3/3

Correctly sketched and labelled the transformed curve.

7(c)(i) 0/1

The answer must be written mathematically as an inequality in terms of x.

Fix: inequalities must be written mathematically in terms of x

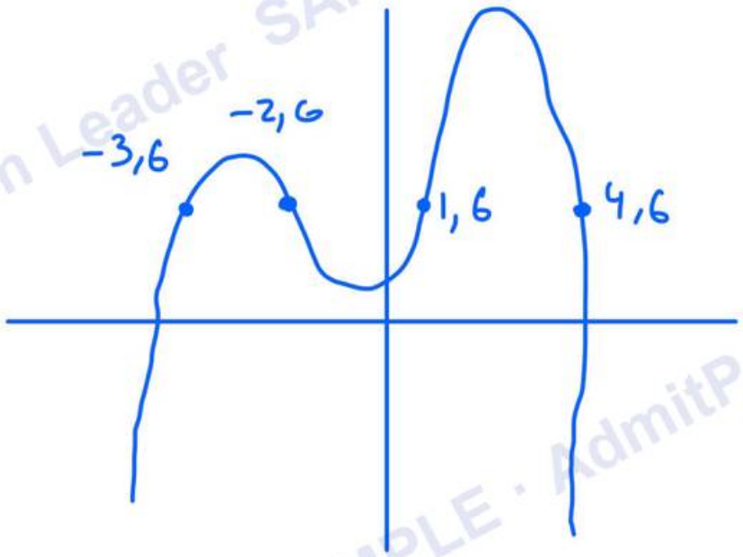
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Question 7 continued

ii) between −3 and −2

( )

i)



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Question 7 (continued) 4/8

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The question requires the inequalities to be written strictly in terms of x.

Fix: inequalities must be written mathematically in terms of x

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Correct answer.

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Correctly sketched and labelled the transformed curve.

7(c)(i) 0/1

The answer must be written mathematically as an inequality in terms of x.

Fix: inequalities must be written mathematically in terms of x

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Question 7 continued

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Question 7 (continued) 4/8

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The question requires the inequalities to be written strictly in terms of x.

Fix: inequalities must be written mathematically in terms of x

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Correct answer.

7(c)(i) 3/3

Correctly sketched and labelled the transformed curve.

7(c)(i) 0/1

The answer must be written mathematically as an inequality in terms of x.

Fix: inequalities must be written mathematically in terms of x

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Question 7 continued

(Total for Question 7 is 8 marks)

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Question 7 (continued) 4/8

7(a) 0/3

The question requires the inequalities to be written strictly in terms of x.

Fix: inequalities must be written mathematically in terms of x

7(b) 1/1

Correct answer.

7(c)(i) 3/3

Correctly sketched and labelled the transformed curve.

7(c)(i) 0/1

The answer must be written mathematically as an inequality in terms of x.

Fix: inequalities must be written mathematically in terms of x

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8.

Diagram **NOT** to scale

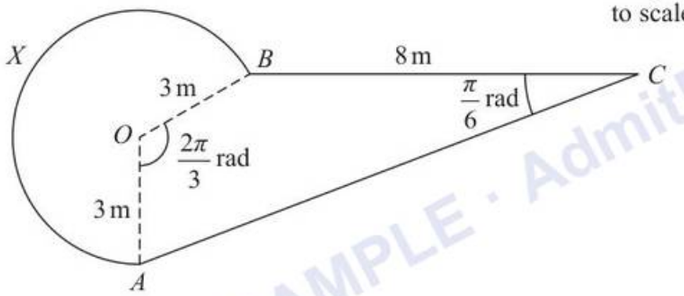


Figure 2

Figure 2 shows the plan view of a design for a pond.

The design consists of a sector $AOBX$ of a circle centre O joined to a quadrilateral $AOBC$.

- $BC = 8\,\text{m}$
- $OA = OB = 3\,\text{m}$
- angle AOB is $\frac{2\pi}{3}$ radians
- angle BCA is $\frac{\pi}{6}$ radians

(a) Calculate (i) the exact area of the sector $AOBX$,

(ii) the exact perimeter of the sector $AOBX$.

(5)

(b) Calculate the exact area of the triangle AOB.

(2)

(c) Show that the length AB is $3\sqrt{3}$ m.

(2)

(d) Find the total surface area of the pond. Give your answer in m^2 correct to 2 significant figures.

(5)

a) i) $2\pi - \frac{2\pi}{3} = \frac{4}{3}\pi$

$a = \frac{r^2\theta}{2} = \frac{3^2 \times \frac{4}{3}\pi}{2} = 6\pi\,\text{m}^2$

ii) $s = r\theta = 3 \times \frac{4}{3}\pi = 4\pi\,\text{m}$

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Sample script · whole paper 46/75

Question 8 — 7/14

8(a)(i) 3/3

Correct method and final exact area.

8(a)(i) 1/2

Correctly found the arc length (M1), but failed to add the two radii to find the total perimeter.

Fix: calculated arc length but did not add the two radii for the perimeter

8(b) 2/2

Valid alternative method using the base AB and angle OBA to calculate the exact area of the triangle AOB.

8(c) 1/2

Correct application of the cosine rule (M1). The A1* mark is lost because an unsimplified exact value for c^2 (such as 27) was not shown before stating the final simplified surd.

Fix: did not show an unsimplified exact value for AB^2 before stating the final surd

8(d) 0/5

The student did not calculate or include the area of triangle ABC in the total surface area.

Fix: did not calculate or include the area of triangle ABC in the total surface area

Question 8 continued

b+c) $\frac{2\pi}{3} + 2x = \pi$

$x = \pi - \frac{2\pi}{3} \quad \times\frac{1}{2} = \frac{\pi}{6}$

$c^2 = 3^2 + 3^2 - 2(3)(3)\cos\frac{2\pi}{3}$

$c = 3\sqrt{3}$

$\frac{1}{2}ab\sin C$

$\frac{1}{2} 3\sqrt{3} \times 3 \sin\frac{\pi}{6} = \frac{9\sqrt{3}}{4} m^2$

d) $6\pi + \frac{9\sqrt{3}}{4} = 22.75 m^2$
$= 23 m^2$

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Sample script · whole paper 46/75

Question 8 (continued) 7/14

8(a)(i) 3/3

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Fix: did not show an unsimplified exact value for AB^2 before stating the final surd

8(d) 0/5

The student did not calculate or include the area of triangle ABC in the total surface area.

Fix: did not calculate or include the area of triangle ABC in the total surface area

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Question 8 continued

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Question 8 (continued) 7/14

8(a)(i) 3/3

Correct method and final exact area.

8(a)(i) 1/2

Correctly found the arc length (M1), but failed to add the two radii to find the total perimeter.

Fix: calculated arc length but did not add the two radii for the perimeter

8(b) 2/2

Valid alternative method using the base AB and angle OBA to calculate the exact area of the triangle AOB.

8(c) 1/2

Correct application of the cosine rule (M1). The A1* mark is lost because an unsimplified exact value for c^2 (such as 27) was not shown before stating the final simplified surd.

Fix: did not show an unsimplified exact value for AB^2 before stating the final surd

8(d) 0/5

The student did not calculate or include the area of triangle ABC in the total surface area.

Fix: did not calculate or include the area of triangle ABC in the total surface area

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Question 8 continued

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(Total for Question 8 is 14 marks)

Marked by: Team Leader

Sample script · whole paper 46/75

Question 8 (continued) 7/14

8(a)(i) 3/3

Correct method and final exact area.

8(a)(i) 1/2

Correctly found the arc length (M1), but failed to add the two radii to find the total perimeter.

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8(b) 2/2

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The student did not calculate or include the area of triangle ABC in the total surface area.

Fix: did not calculate or include the area of triangle ABC in the total surface area

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9.

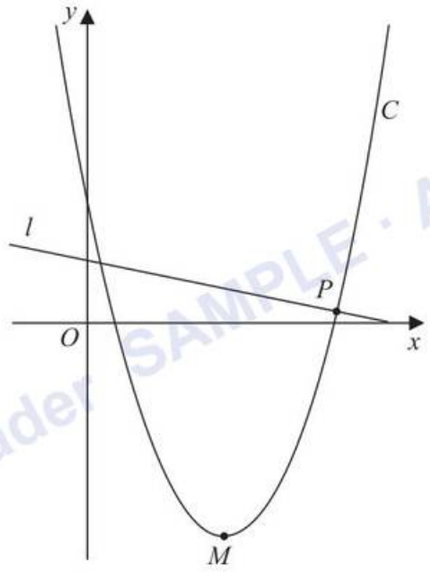


Figure 3

Figure 3 shows a sketch of the curve C with equation

$$y = \frac{1}{2}x^2 - 10x + 22$$

(a) Write $\frac{1}{2}x^2 - 10x + 22$ in the form

$$a(x + b)^2 + c$$

where a, b and c are constants to be found.

(3)

The point M is the minimum turning point of C, as shown in Figure 3.

(b) Deduce the coordinates of M

(2)

The line l is the normal to C at the point P, as shown in Figure 3.

Given that l has equation $y = k - \frac{1}{8}x$, where k is a constant,

(c) (i) find the coordinates of P

(ii) find the value of k

(6)

Question 9 continues on the next page

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Marked by: Team Leader

Sample script · whole paper 46/75

Question 9 — 12/14

9(a) 3/3

Correctly completed the square.

9(b) 1/2

Follow through mark given for the y-coordinate (-28). The x-coordinate was incorrectly extracted from the completed square form.

Fix: incorrectly extracted the x-coordinate of the vertex from the completed square form

9(c)(i) 4/4

Correctly equated derivative to tangent gradient and found coordinates of P.

9(c)(i) 2/2

Correctly substituted P into normal equation to find k.

9(d) 2/3

Correctly identified two of the three inequalities. The boundary for the vertical line x >= 10 was missing.

Fix: omitted the inequality for the vertical line boundary x >= 10

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Question 9 continued

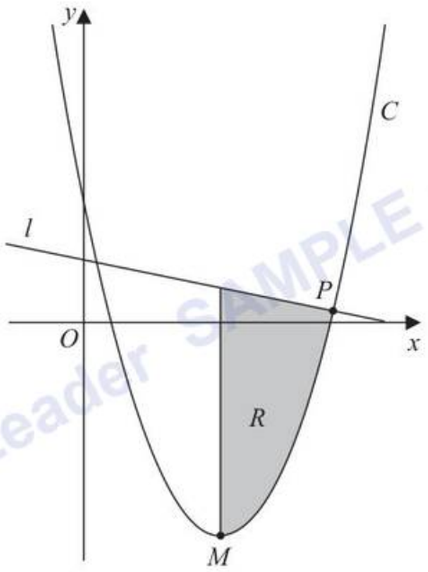


Figure 4

Figure 4 is a copy of Figure 3. The finite region R, shown shaded in Figure 4, is bounded by l, C and the line through M parallel to the y-axis.

(d) Identify the inequalities that define R.

(3)

a) $\frac{1}{2}(x-10)^2 - 28$

$\frac{1}{2}x^2 - 10x + 22$

$\frac{1}{2}(x^2 - 20x + 100) - 28$

$\frac{1}{2}x^2 - 10x + 50 - 28$

$\frac{1}{2}x^2 - 10x + 22$

b) $-10, -28$

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Marked by: Team Leader

Sample script · whole paper 46/75

Question 9 (continued) **12/14**

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Fix: omitted the inequality for the vertical line boundary x >= 10

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Question 9 continued

c)

i) $\frac{dy}{dx} = x - 10$

$x - 10 = 8$

$x = 18$

$y = \frac{1}{2}(18)^2 - 10(18) + 22 = 4$

P is 18, 4

ii) $4 = k - \frac{1}{8}(18)$

$k = \frac{25}{4}$

d) $y \geq \frac{1}{2}x^2 - 10x + 22$

$y \leq k - \frac{1}{8}x$

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P 7 2 1 3 7 A 0 2 6 2 8

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Sample script · whole paper 46/75

Question 9 (continued) 12/14

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Question 9 continued

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Question 9 (continued) 12/14

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Question 9 continued

(Total for Question 9 is 14 marks)

TOTAL FOR PAPER IS 75 MARKS

P 7 2 1 3 7 A 0 2 8 2 8

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Question 9 (continued) 12/14

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