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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: 48/75

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

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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

All three terms differentiated correctly with indices processed, so M1A1A1.

1(b) 0/3

They substituted x = 2 into y, not dy/dx, so the gradient is wrong (M0). The line mark depends on that, and the answer is not in the form ax + by + c = 0.

Fix: tangent gradient 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

All three terms differentiated correctly with indices processed, so M1A1A1.

1(b) 0/3

They substituted x = 2 into y, not dy/dx, so the gradient is wrong (M0). The line mark depends on that, and the answer is not in the form ax + by + c = 0.

Fix: tangent gradient 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

The expansion is correct and both constants are found.

2(b) 4/5

The first two terms are split and integrated correctly (M1A1M1A1). The third term lost its factor of 5 and −3x^(−1/2) was integrated to −3√x instead of −6√x, so the final A1 is withheld.

Fix: dividing every term by 5; integrating negative power

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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

The expansion is correct and both constants are found.

2(b) 4/5

The first two terms are split and integrated correctly (M1A1M1A1). The third term lost its factor of 5 and −3x^(−1/2) was integrated to −3√x instead of −6√x, so the final A1 is withheld.

Fix: dividing every term by 5; integrating negative power

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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

Simultaneous equations are set up and solved, giving both constants correctly.

3(b) 1/2

The method is correct (M1), but the answer was left as 47/6 and not given as 7.8 to 1 d.p., so the A1 is not earned.

Fix: not following the requested rounding

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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

Simultaneous equations are set up and solved, giving both constants correctly.

3(b) 1/2

The method is correct (M1), but the answer was left as 47/6 and not given as 7.8 to 1 d.p., so the A1 is not earned.

Fix: not following the requested rounding

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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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P 7 2 1 3 7 A 0 8 2 8

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Question 4 — 3/6

4(a) 2/4

Cancelling x to reach a quadratic and then using the formula earn M1dM1. The quadratic should be $2x^2+x-15$, so the roots are wrong. Losing x = 0 is why the B1 and A1 are not earned.

Fix: algebra slip when cancelling x; losing the root x = 0

4(b) 1/2

They show a method for the fractional power using their positive root (M1). There is no exact surd answer, so A0.

Fix: exact surd answer required

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Question 4 continued

(Total for Question 4 is 6 marks)

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Question 4 (continued) 3/6

4(a) 2/4

Cancelling x to reach a quadratic and then using the formula earn M1dM1. The quadratic should be $2x^2+x-15$, so the roots are wrong. Losing x = 0 is why the B1 and A1 are not earned.

Fix: algebra slip when cancelling x; losing the root x = 0

4(b) 1/2

They show a method for the fractional power using their positive root (M1). There is no exact surd answer, so A0.

Fix: exact surd answer required

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

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

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

$24\sqrt{9} + \frac{9^2}{6} - 4(6) + C = 8$

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

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

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

The integration is correct (M1A1A1) and they attempt to find c (dM1). The substitution used −4(6) and RHS 6 instead of −4(9) and 8, so c and the final A1 are wrong.
Fix: substituting the given point accurately

5(b) 1/4

f′(9) = 3 is correct (M1). They used it as the normal gradient and never took the negative reciprocal, so the remaining marks are lost.
Fix: normal gradient is the negative reciprocal

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Question 5 continued

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Question 5 (continued) 5/9

5(a) 4/5

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Fix: substituting the given point accurately

5(b) 1/4

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Fix: normal gradient is the negative reciprocal

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Question 5 continued

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Question 5 (continued) 5/9

5(a) 4/5

The integration is correct (M1A1A1) and they attempt to find c (dM1). The substitution used −4(6) and RHS 6 instead of −4(9) and 8, so c and the final A1 are wrong.

Fix: substituting the given point accurately

5(b) 1/4

f′(9) = 3 is correct (M1). They used it as the normal gradient and never took the negative reciprocal, so the remaining marks are lost.

Fix: normal gradient is the negative reciprocal

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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

The integration is correct (M1A1A1) and they attempt to find c (dM1). The substitution used −4(6) and RHS 6 instead of −4(9) and 8, so c and the final A1 are wrong.

Fix: substituting the given point accurately

5(b) 1/4

f′(9) = 3 is correct (M1). They used it as the normal gradient and never took the negative reciprocal, so the remaining marks are lost.

Fix: normal gradient is the negative reciprocal

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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.

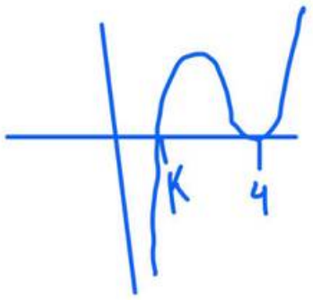
(5)

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

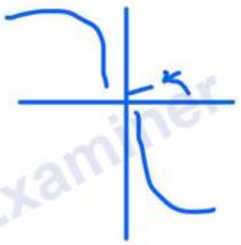
$$(2x - k)(x + 4)^2 = \frac{k}{x^2}$$

(1)

i)



ii)



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Question 6 1/6

6(a) 1/5

Only the positive cubic shape earns a mark. The double root should be at x = −4 and the root at k/2. There is no y-intercept of −16k. The k/x² sketch is the wrong shape and in the wrong quadrants.

Fix: double root at x = −4; k/x² lies in quadrants 1 and 2

6(b) 0/1

The graphs from (a) are wrong, so the mark is unavailable. The correct answer is one root because the graphs intersect once.

Fix: conclusion must follow from correct sketches

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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) 1/6

6(a) 1/5

Only the positive cubic shape earns a mark. The double root should be at x = −4 and the root at k/2. There is no y-intercept of −16k. The k/x² sketch is the wrong shape and in the wrong quadrants.

Fix: double root at x = −4; k/x² lies in quadrants 1 and 2

6(b) 0/1

The graphs from (a) are wrong, so the mark is unavailable. The correct answer is one root because the graphs intersect once.

Fix: conclusion must follow from correct sketches

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7.

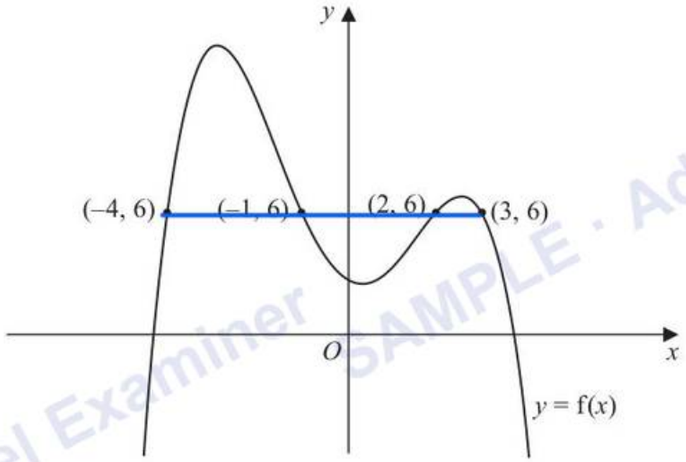


Figure 1

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 — 7/8

7(a) 3/3

Both ends of the inside region and the outer regions are correct, so M1A1B1.

7(b) 1/1

Correct: the largest solution is x = 3/2.

7(c) 3/4

The reflection and all four points are correct (3 marks). The set of values is given in words as "between" with no inequality in x, and −3 ≤ x ≤ −2 (inclusive) is required.

Fix: state solution set as inclusive inequality

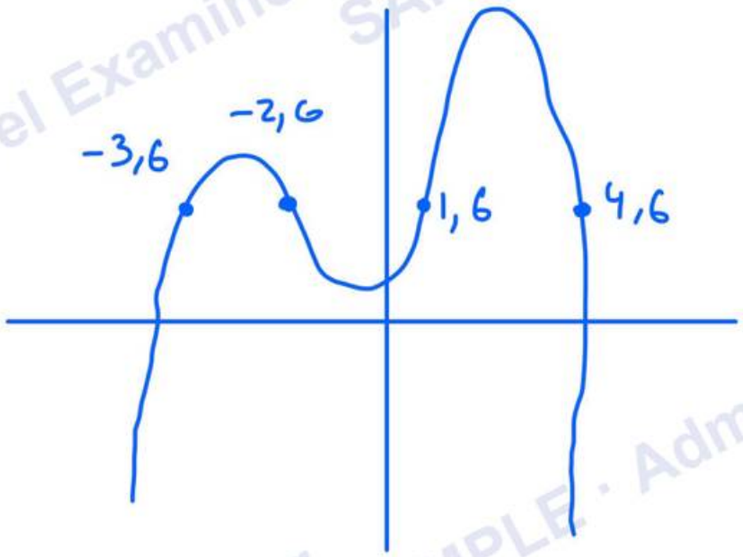
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Question 7 continued

ii) between −3 and −2

( )

i)



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Question 7 (continued) 7/8

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Fix: state solution set as inclusive inequality

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Question 7 continued

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Question 7 (continued) 7/8

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Correct: the largest solution is $x = 3/2$.

7(c) 3/4

The reflection and all four points are correct (3 marks). The set of values is given in words as "between" with no inequality in x, and $-3 \leq x \leq -2$ (inclusive) is required.

Fix: state solution set as inclusive inequality

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Question 7 continued

(Total for Question 7 is 8 marks)

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Question 7 (continued) 7/8

7(a) 3/3

Both ends of the inside region and the outer regions are correct, so M1A1B1.

7(b) 1/1

Correct: the largest solution is $x = 3/2$.

7(c) 3/4

The reflection and all four points are correct (3 marks). The set of values is given in words as "between" with no inequality in x, and $-3 \leq x \leq -2$ (inclusive) is required.

Fix: state solution set as inclusive inequality

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8.

Diagram **NOT** to scale

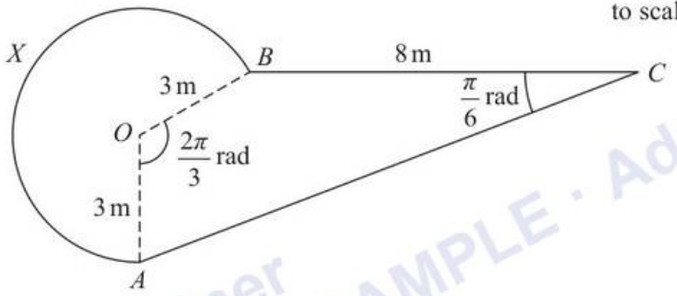


Figure 2

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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Question 8 — 7/14

8(a) 4/5

Angle, area (M1A1) and the arc-length method earn the marks. The perimeter must include the two radii, 4π + 6, so that A1 is lost.

Fix: perimeter includes the straight edges

8(b) 2/2

A valid area formula is used with the correct sides and angle, giving 9√3/4.

8(c) 1/2

The cosine rule method is correct (M1). No simplified intermediate such as $AB^2 = 27$ is shown, so the A1* is withheld.

Fix: show-that needs an intermediate simplified step

8(d) 0/5

Triangle ABC was never found: no sine rule or angle BAC and no area of ABC. The sum omits it, so the total of 23 is wrong, not the required 43.

Fix: include every region of the composite shape

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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Question 8 (continued) 7/14

8(a) 4/5

Angle, area (M1A1) and the arc-length method earn the marks. The perimeter must include the two radii, 4π + 6, so that A1 is lost.

Fix: perimeter includes the straight edges

8(b) 2/2

A valid area formula is used with the correct sides and angle, giving 9√3/4.

8(c) 1/2

The cosine rule method is correct (M1). No simplified intermediate such as $AB^2 = 27$ is shown, so the A1* is withheld.

Fix: show-that needs an intermediate simplified step

8(d) 0/5

Triangle ABC was never found: no sine rule or angle BAC and no area of ABC. The sum omits it, so the total of 23 is wrong, not the required 43.

Fix: include every region of the composite shape

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Question 8 continued

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Question 8 continued

(Total for Question 8 is 14 marks)

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9.

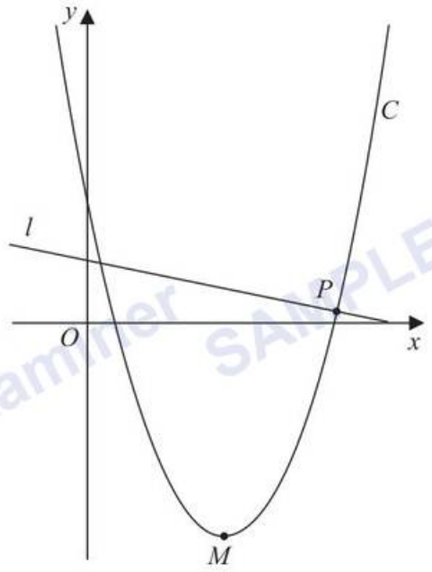


Figure 3

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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Question 9 — 12/14

9(a) 3/3

Completing the square is correct, giving a = ½, b = −10, c = −28.

9(b) 1/2

The y-coordinate −28 is correct. The x-coordinate should be 10, since the turning point is at x = −b.

Fix: turning point x-coordinate is −b

9(c) 6/6

The tangent gradient 8 is used correctly to find P, then k = 25/4 from P on the normal.

9(d) 2/3

Two of the three bounds are given. The line x ≥ 10 through M is missing.

Fix: include all boundaries of the region

Question 9 continued

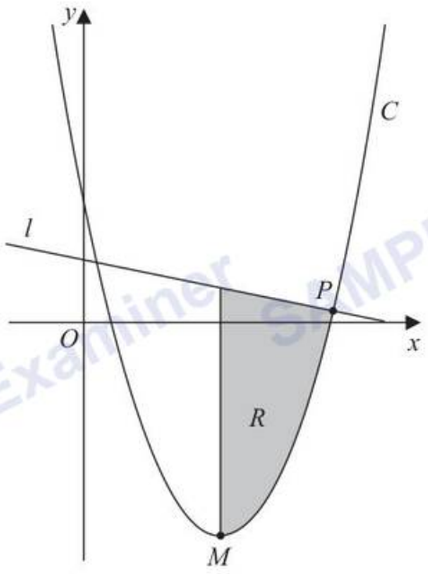


Figure 4

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) $\frac{1}{2}(x-10)^2-28$ $\frac{1}{2}x^2-10x+22$

$\frac{1}{2}(x2-20x+100)-28$

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

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

b) $-10, -28$

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Sample script · whole paper 48/75

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

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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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Question 9 continued

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Question 9 (continued) 12/14

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Question 9 continued

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(Total for Question 9 is 14 marks)

TOTAL FOR PAPER IS 75 MARKS

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