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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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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 ▶

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Sample script · whole paper 48/75
Cover page. Marking starts on page 2.

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

Earns M1A1A1 for correctly differentiating all three terms and simplifying.

1(b) 0/3

The original function, not the derivative, is evaluated to obtain the gradient, so M1 is withheld. The dependent line-method mark and final accuracy mark are consequently unavailable.

Fix: tangent gradient is dy/dx, 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

Earns M1A1A1 for correctly differentiating all three terms and simplifying.

1(b) 0/3

The original function, not the derivative, is evaluated to obtain the gradient, so M1 is withheld. The dependent line-method mark and final accuracy mark are consequently unavailable.

Fix: tangent gradient is dy/dx, 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

Both coefficients are correct, earning B1B1.

2(b) 4/5

Earns both method marks and both partial accuracy marks for the first two correct terms in the integrand and integral. The final A1 is withheld because the last two integrated terms should be −64/15 x^1.5 and −6√x.

Fix: divide every term correctly and apply the integration power rule

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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

Both coefficients are correct, earning B1B1.

2(b) 4/5

Earns both method marks and both partial accuracy marks for the first two correct terms in the integrand and integral. The final A1 is withheld because the last two integrated terms should be −64/15 x^1.5 and −6√x.

Fix: divide every term correctly and apply the integration power rule

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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

Correct simultaneous equations and solutions earn M1A1A1.

3(b) 1/2

Earns M1 for correctly finding the time. A1 is withheld because the required one-decimal-place answer, 7.8, is not given.

Fix: give the requested decimal precision

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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

Correct simultaneous equations and solutions earn M1A1A1.

3(b) 1/2

Earns M1 for correctly finding the time. A1 is withheld because the required one-decimal-place answer, 7.8, is not given.

Fix: give the requested decimal precision

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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 — 3/6

4(a) 2/4

Earns M1 for cancelling x to obtain a quadratic and dM1 for applying the quadratic formula to that quadratic. Neither accuracy mark is earned: the coefficient of x is wrong and x = 0 is lost.

Fix: expand carefully and retain roots when cancelling

4(b) 1/2

Earns M1 for explicitly undoing the fractional power using the positive solution from part (a). A1 is withheld because the exact simplified surd solution is not obtained.

Fix: retain exact values for a surd solution

Question 4 continued

(Total for Question 4 is 6 marks)

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Question 4 (continued) 3/6

4(a) 2/4

Earns M1 for cancelling x to obtain a quadratic and dM1 for applying the quadratic formula to that quadratic. Neither accuracy mark is earned: the coefficient of x is wrong and x = 0 is lost.

Fix: expand carefully and retain roots when cancelling

4(b) 1/2

Earns M1 for explicitly undoing the fractional power using the positive solution from part (a). A1 is withheld because the exact simplified surd solution is not obtained.

Fix: retain exact values for a surd solution

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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

The correct integration earns M1A1A1, and the attempt to use P to find C earns dM1. The final A1 is withheld because substituting 6 in the −4x term gives the wrong constant.

Fix: substitute the same x-coordinate into every term

5(b) 1/4

Earns M1 for evaluating f'(9). The negative reciprocal is not taken, and no normal with a changed gradient is used to find its y-axis crossing, so the remaining marks are withheld.

Fix: normal gradient is the negative reciprocal

Question 5 continued

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Question 5 (continued) 5/9

5(a) 4/5

The correct integration earns M1A1A1, and the attempt to use P to find C earns dM1. The final A1 is withheld because substituting 6 in the −4x term gives the wrong constant.

Fix: substitute the same x-coordinate into every term

5(b) 1/4

Earns M1 for evaluating f′(9). The negative reciprocal is not taken, and no normal with a changed gradient is used to find its y-axis crossing, so the remaining marks are withheld.

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 correct integration earns M1A1A1, and the attempt to use P to find C earns dM1. The final A1 is withheld because substituting 6 in the −4x term gives the wrong constant.

Fix: substitute the same x-coordinate into every term

5(b) 1/4

Earns M1 for evaluating f′(9). The negative reciprocal is not taken, and no normal with a changed gradient is used to find its y-axis crossing, so the remaining marks are withheld.

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 correct integration earns M1A1A1, and the attempt to use P to find C earns dM1. The final A1 is withheld because substituting 6 in the −4x term gives the wrong constant.

Fix: substitute the same x-coordinate into every term

5(b) 1/4

Earns M1 for evaluating f′(9). The negative reciprocal is not taken, and no normal with a changed gradient is used to find its y-axis crossing, so the remaining marks are withheld.

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.

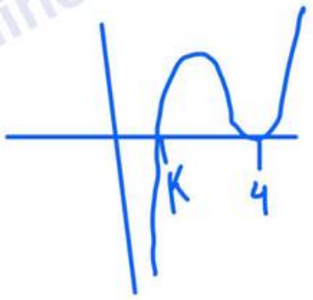
(5)

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

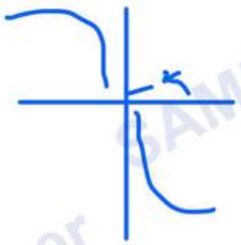
$$(2x - k)(x + 4)^2 = \frac{k}{x^2}$$

(1)

i)



ii)



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Question 6 1/6

6(a)(i) 1/3

Earns B1 for a positive cubic shape with two turning points. The intercept/location mark and y-intercept mark are withheld because the roots are incorrectly positioned and −16k is not identified.

Fix: find roots and intercepts before sketching

6(a)(i) 0/2

Neither B mark is earned: the second-quadrant branch has the wrong trend, and the other branch lies below the x-axis rather than in quadrant 1.

Fix: a positive constant divided by x² is always positive

6(b) 0/1

B1 is withheld because the correct graphs intersect once; the required correct sketches are also absent.

Fix: equation roots correspond to graph intersections

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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)(i) 1/3

Earns B1 for a positive cubic shape with two turning points. The intercept/location mark and y-intercept mark are withheld because the roots are incorrectly positioned and −16k is not identified.

Fix: find roots and intercepts before sketching

6(a)(i) 0/2

Neither B mark is earned: the second-quadrant branch has the wrong trend, and the other branch lies below the x-axis rather than in quadrant 1.

Fix: a positive constant divided by x^2 is always positive

6(b) 0/1

B1 is withheld because the correct graphs intersect once; the required correct sketches are also absent.

Fix: equation roots correspond to graph intersections

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7.

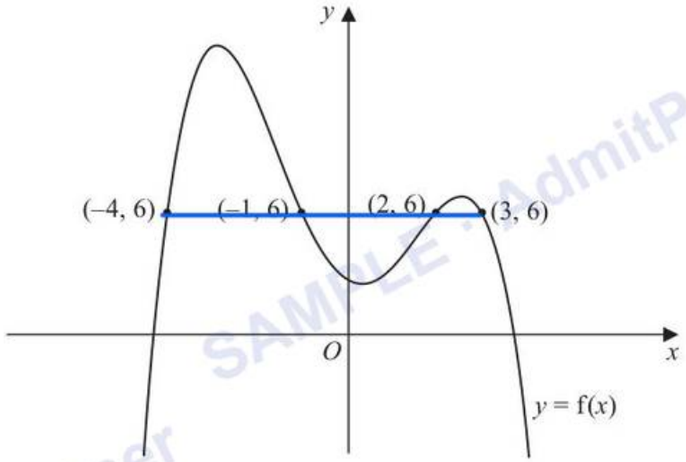


Figure 1

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

The verbal ranges correctly describe x < −4, −1 < x < 2 and x > 3, earning M1A1B1.

7(b) 1/1

The largest solution is correct, earning B1.

7(c)(i) 3/3

The correct reflection and all four correctly transformed coordinates earn B1B1B1.

7(c)(i) 0/1

B1 is withheld because the answer does not specify that both endpoints are included; the required set is −3 ≤ x ≤ −2.

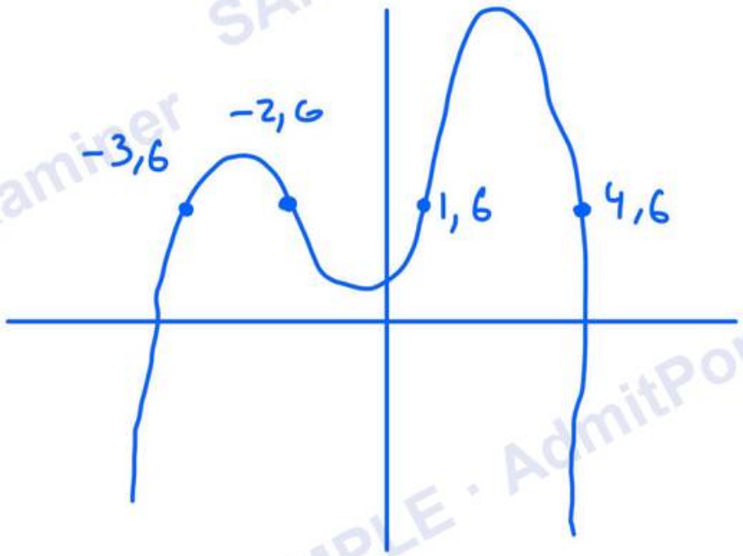
Fix: inclusive inequalities include the endpoints

Question 7 continued

ii) between −3 and −2

( )

i)



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Question 7 (continued) 7/8

7(a) 3/3

The verbal ranges correctly describe $x < -4$, $-1 < x < 2$ and $x > 3$, earning M1A1B1.

7(b) 1/1

The largest solution is correct, earning B1.

7(c)(i) 3/3

The correct reflection and all four correctly transformed coordinates earn B1B1B1.

7(c)(i) 0/1

B1 is withheld because the answer does not specify that both endpoints are included; the required set is $-3 \leq x \leq -2$.

Fix: inclusive inequalities include the endpoints

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Question 7 continued

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Question 7 (continued) 7/8

7(a) 3/3

The verbal ranges correctly describe $x < -4$, $-1 < x < 2$ and $x > 3$, earning M1A1B1.

7(b) 1/1

The largest solution is correct, earning B1.

7(c)(i) 3/3

The correct reflection and all four correctly transformed coordinates earn B1B1B1.

7(c)(i) 0/1

B1 is withheld because the answer does not specify that both endpoints are included; the required set is $-3 \leq x \leq -2$.

Fix: inclusive inequalities include the endpoints

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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

The verbal ranges correctly describe $x < -4$, $-1 < x < 2$ and $x > 3$, earning M1A1B1.

7(b) 1/1

The largest solution is correct, earning B1.

7(c)(i) 3/3

The correct reflection and all four correctly transformed coordinates earn B1B1B1.

7(c)(i) 0/1

B1 is withheld because the answer does not specify that both endpoints are included; the required set is $-3 \leq x \leq -2$.

Fix: inclusive inequalities include the endpoints

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8.

Diagram **NOT** to scale

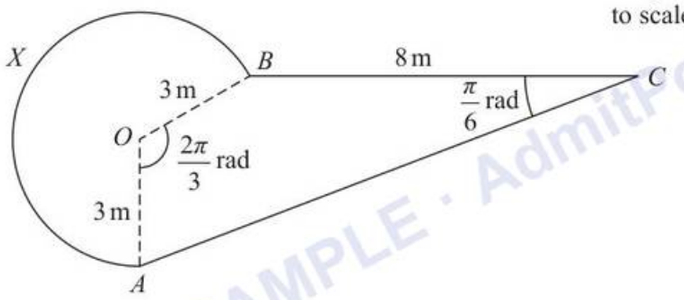


Figure 2

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)(i) 3/3

The correct major-sector angle, formula and exact area earn B1M1A1.

8(a)(i) 1/2

Earns M1 for finding the arc length. A1 is withheld because the two radii are omitted from the sector perimeter.

Fix: sector perimeter includes two radii

8(b) 2/2

Using AB and OA with their included angle π/6 is a correct alternative method, earning M1A1.

8(c) 1/2

Earns M1 for the correct cosine-rule setup. The proof accuracy mark is withheld because no intermediate simplified expression such as $c^2 = 27$ is shown, as required by the scheme.

Fix: show the intermediate simplification in a proof

8(d) 0/5

No method is shown to find triangle ABC, so neither initial method mark nor its accuracy mark is earned. Adding only the sector and triangle AOB cannot earn the dependent total-area mark or final A1.

Fix: include every component of the pond 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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P 7 2 1 3 7 A 0 2 1 2 8

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Sample script · whole paper 48/75

Question 8 (continued) 7/14

8(a)(i) 3/3

The correct major-sector angle, formula and exact area earn B1M1A1.

8(a)(i) 1/2

Earns M1 for finding the arc length. A1 is withheld because the two radii are omitted from the sector perimeter.

Fix: sector perimeter includes two radii

8(b) 2/2

Using AB and OA with their included angle π/6 is a correct alternative method, earning M1A1.

8(c) 1/2

Earns M1 for the correct cosine-rule setup. The proof accuracy mark is withheld because no intermediate simplified expression such as $c^2 = 27$ is shown, as required by the scheme.

Fix: show the intermediate simplification in a proof

8(d) 0/5

No method is shown to find triangle ABC, so neither initial method mark nor its accuracy mark is earned. Adding only the sector and triangle AOB cannot earn the dependent total-area mark or final A1.

Fix: include every component of the pond area

Question 8 continued

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

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Question 8 continued

(Total for Question 8 is 14 marks)

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Question 8 (continued) 7/14

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9.

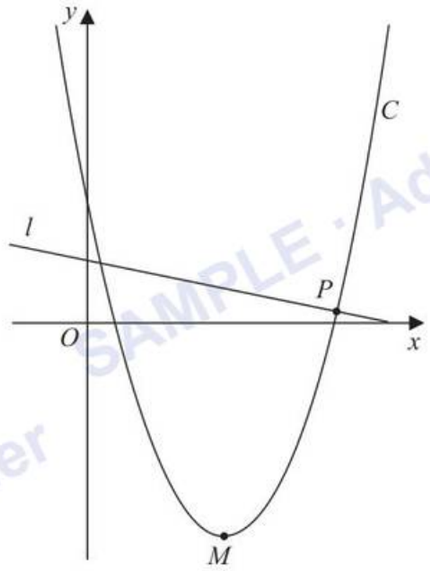


Figure 3

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

The correct completed-square expression and verification earn B1M1A1.

9(b) 1/2

Earns one B1ft for the correct y-coordinate. The x-coordinate should be 10, not −10, so the second B1ft is withheld.

Fix: turning point occurs when the squared bracket is zero

9(c)(i) 4/4

The implied tangent gradient 8, differentiation and both correct coordinates earn B1M1A1A1.

9(c)(i) 2/2

Substitution of P into the normal equation is implied by the correct result, earning dM1A1.

9(d) 2/3

The two correct curve and line inequalities earn B1ftB1ft. The final B1 is withheld because the boundary condition x ≥ 10 is missing.

Fix: include the vertical boundary inequality

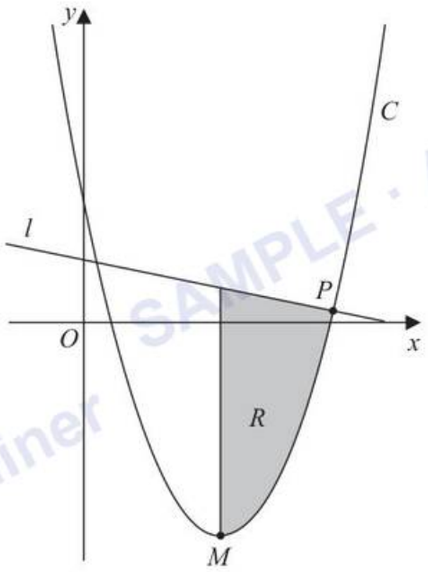


Figure 4

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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Question 9 (continued) 12/14

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The two correct curve and line inequalities earn B1ftB1ft. The final B1 is withheld because the boundary condition $x \geq 10$ is missing.

Fix: include the vertical boundary inequality

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

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

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

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Question 9 (continued) 12/14

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Fix: include the vertical boundary inequality

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Question 9 continued

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Question 9 (continued) 12/14

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Fix: include the vertical boundary inequality

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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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Question 9 (continued) 12/14

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Fix: include the vertical boundary inequality