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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

Question 1	3 / 6 (page 2)
Question 2	6 / 7 (page 4)
Question 3	4 / 5 (page 6)
Question 4	2 / 6 (page 8)
Question 5	5 / 9 (page 10)
Question 6	2 / 6 (page 14)
Question 7	5 / 8 (page 16)
Question 8	7 / 14 (page 20)
Question 9	12 / 14 (page 24)

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 ▶

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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 are correct and simplified on one line, so M1A1A1.

1(b) 0/3

Substituted x=2 into y rather than dy/dx, so no gradient from a changed function (M0). dM0 and A0 follow.

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 are correct and simplified on one line, so M1A1A1.

1(b) 0/3

Substituted x=2 into y rather than dy/dx, so no gradient from a changed function (M0). dM0 and A0 follow.

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

Expansion is correct, giving both values. B1B1.

2(b) 4/5

Split into terms with two correct (M1A1), powers raised (M1), and two integrated terms correct (A1). The third term lost its /5 (giving 64/3, not 64/15) and the last term should be −6√x, so the final A0.

Fix: divide every term by 5√x and integrate x^(-1/2) to 2x^(1/2)

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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

Expansion is correct, giving both values. B1B1.

2(b) 4/5

Split into terms with two correct (M1A1), powers raised (M1), and two integrated terms correct (A1). The third term lost its /5 (giving 64/3, not 64/15) and the last term should be −6√x, so the final A0.

Fix: divide every term by 5√x and integrate x^(-1/2) to 2x^(1/2)

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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 solved correctly for both p and q. M1A1A1.

3(b) 1/2

Correct rearrangement earns M1. The answer was not given to 1 d.p. as 7.8, so A0.

Fix: give the answer in the requested form (1 d.p.)

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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 solved correctly for both p and q. M1A1A1.

3(b) 1/2

Correct rearrangement earns M1. The answer was not given to 1 d.p. as 7.8, so A0.

Fix: give the answer in the requested form (1 d.p.)

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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

Cancelling x to reach a quadratic earns M1, and the formula is applied correctly to their quadratic (dM1). The quadratic should be $2x^2+x-15$, and cancelling x lost the root x=0, so none of 0, 5/2, −3 appear: B0A0.

Fix: don't divide by x — factor it out to keep x=0; expand x(2x+1) carefully

4(b) 0/2

Uses a decimal root, which is not accepted in a no-calculator question. Inverting the 2/3 power is also wrong, so M0A0.

Fix: to undo y^(2/3)=a, raise both sides to the power 3/2

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Question 4 continued

(Total for Question 4 is 6 marks)

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Question 4 (continued) 2/6

4(a) 2/4

Cancelling x to reach a quadratic earns M1, and the formula is applied correctly to their quadratic (dM1). The quadratic should be $2x^2+x-15$, and cancelling x lost the root x=0, so none of 0, 5/2, −3 appear: B0A0.

Fix: don't divide by x — factor it out to keep x=0; expand x(2x+1) carefully

4(b) 0/2

Uses a decimal root, which is not accepted in a no-calculator question. Inverting the 2/3 power is also wrong, so M0A0.

Fix: to undo y^(2/3)=a, raise both sides to the power 3/2

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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

Integration is fully correct (M1A1A1), and substituting to find C earns dM1. Substituting 6 instead of 9 in the −4x term gives the wrong constant (should be −83/2), so A0.
Fix: substitute the given point consistently into every term

5(b) 1/4

Finding f'(9) = 3 earns M1. The negative reciprocal was not taken, so dM0, and with no normal line found M0A0. The answer should be (0, 11).
Fix: normal gradient is −1/(tangent gradient)

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Question 5 continued

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Question 5 (continued) 5/9

5(a) 4/5

Integration is fully correct (M1A1A1), and substituting to find C earns dM1. Substituting 6 instead of 9 in the −4x term gives the wrong constant (should be −83/2), so A0.

Fix: substitute the given point consistently into every term

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Fix: normal gradient is −1/(tangent gradient)

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Question 5 continued

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Question 5 (continued) 5/9

5(a) 4/5

Integration is fully correct (M1A1A1), and substituting to find C earns dM1. Substituting 6 instead of 9 in the −4x term gives the wrong constant (should be −83/2), so A0.
Fix: substitute the given point consistently into every term

5(b) 1/4

Finding f'(9) = 3 earns M1. The negative reciprocal was not taken, so dM0, and with no normal line found M0A0. The answer should be (0, 11).
Fix: normal gradient is −1/(tangent gradient)

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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

Integration is fully correct (M1A1A1), and substituting to find C earns dM1. Substituting 6 instead of 9 in the −4x term gives the wrong constant (should be −83/2), so A0.

Fix: substitute the given point consistently into every term

5(b) 1/4

Finding f'(9) = 3 earns M1. The negative reciprocal was not taken, so dM0, and with no normal line found M0A0. The answer should be (0, 11).

Fix: normal gradient is −1/(tangent gradient)

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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.

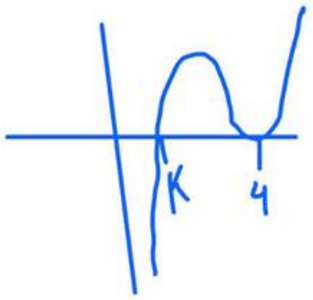
(5)

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

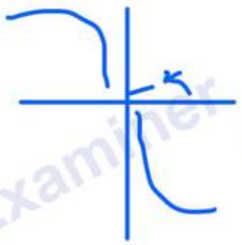
$$(2x - k)(x + 4)^2 = \frac{k}{x^2}$$

(1)

i)



ii)



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Question 6 2/6

6(a)(i) 1/3

A positive cubic shape earns B1. The repeated root is shown at x=4 instead of −4, the crossing is at k not k/2, and there is no y-intercept −16k, so B0B0.

Fix: $(x+4)^2$ gives a touching point at x = −4; root of 2x−k is k/2

6(a)(i) 1/2

The quadrant-2 branch has the correct shape (B1). The branch in quadrant 4 should be in quadrant 1, since $k/x^2 > 0$, so B0.

Fix: k/x^2 is always positive — both branches above the x-axis

6(b) 0/1

The graphs from (a) are incorrect, and the correct answer is one root (one intersection), so B0.

Fix: count intersections of the correctly drawn curves

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) 2/6

6(a)(i) 1/3

A positive cubic shape earns B1. The repeated root is shown at x=4 instead of −4, the crossing is at k not k/2, and there is no y-intercept −16k, so B0B0.

Fix: $(x+4)^2$ gives a touching point at x = −4; root of 2x−k is k/2

6(a)(i) 1/2

The quadrant-2 branch has the correct shape (B1). The branch in quadrant 4 should be in quadrant 1, since $k/x^2 > 0$, so B0.

Fix: k/x^2 is always positive — both branches above the x-axis

6(b) 0/1

The graphs from (a) are incorrect, and the correct answer is one root (one intersection), so B0.

Fix: count intersections of the correctly drawn curves

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7.

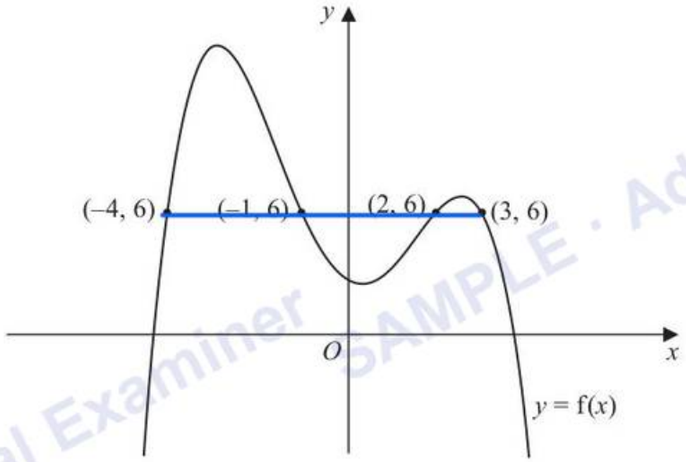


Figure 1

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 5/8

7(a) 1/3

The outer regions x<−4 and x>3 are identified (B1, benefit of doubt). The inner region is given in words, not as −1<x<2 in terms of x, so M0A0.

Fix: write solution sets as inequalities in x

7(b) 1/1

Correct largest solution. B1.

7(c)(i) 3/3

Correct reflection in the y-axis with all four points correct. B1B1B1.

7(c)(i) 0/1

Not written as −3 ≤ x ≤ −2 in terms of x, and inclusive ends are not shown, so B0.

Fix: state final answer as inequality in x with correct inclusivity

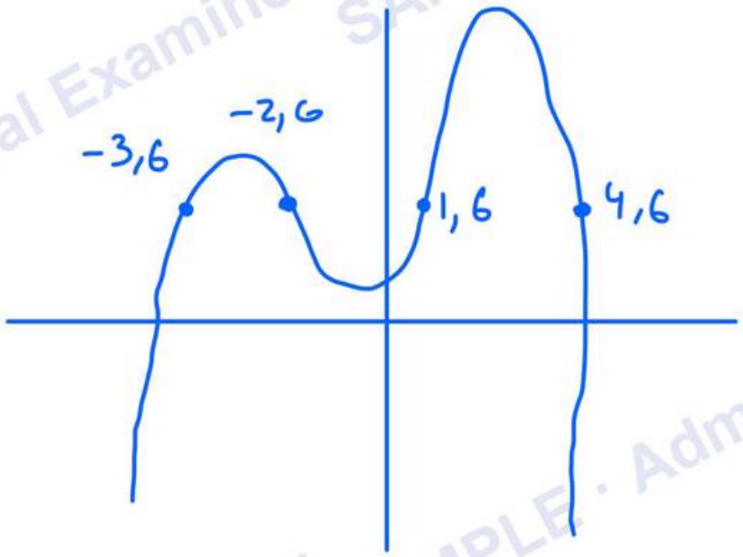
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Question 7 continued

ii) between −3 and −2

( )

i)



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Question 7 (continued) 5/8

7(a) 1/3

The outer regions $x<-4$ and $x>3$ are identified (B1, benefit of doubt). The inner region is given in words, not as $-1<x<2$ in terms of x, so M0A0.

Fix: write solution sets as inequalities in x

7(b) 1/1

Correct largest solution. B1.

7(c)(i) 3/3

Correct reflection in the y-axis with all four points correct. B1B1B1.

7(c)(i) 0/1

Not written as $-3 \leq x \leq -2$ in terms of x, and inclusive ends are not shown, so B0.

Fix: state final answer as inequality in x with correct inclusivity

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Question 7 continued

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Question 7 (continued) 5/8

7(a) 1/3

The outer regions $x<-4$ and $x>3$ are identified (B1, benefit of doubt). The inner region is given in words, not as $-1<x<2$ in terms of x, so M0A0.

Fix: write solution sets as inequalities in x

7(b) 1/1

Correct largest solution. B1.

7(c)(i) 3/3

Correct reflection in the y-axis with all four points correct. B1B1B1.

7(c)(i) 0/1

Not written as $-3 \leq x \leq -2$ in terms of x, and inclusive ends are not shown, so B0.

Fix: state final answer as inequality in x with correct inclusivity

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Question 7 continued

(Total for Question 7 is 8 marks)

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Question 7 (continued) 5/8

7(a) 1/3

The outer regions $x<-4$ and $x>3$ are identified (B1, benefit of doubt). The inner region is given in words, not as $-1<x<2$ in terms of x, so M0A0.

Fix: write solution sets as inequalities in x

7(b) 1/1

Correct largest solution. B1.

7(c)(i) 3/3

Correct reflection in the y-axis with all four points correct. B1B1B1.

7(c)(i) 0/1

Not written as $-3 \leq x \leq -2$ in terms of x, and inclusive ends are not shown, so B0.

Fix: state final answer as inequality in x with correct inclusivity

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8.

Diagram **NOT** to scale

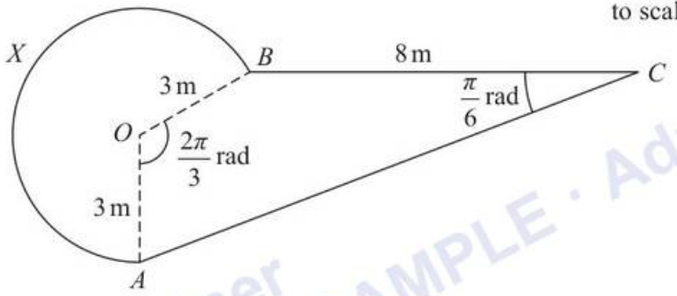


Figure 2

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

Correct angle and area. B1M1A1.

8(a)(i) 1/2

Correct arc length earns M1. The two radii were not added, so the perimeter 4π+6 was not given: A0.

Fix: perimeter of a sector = arc + two radii

8(b) 2/2

Valid ½ab sin C using the base angle π/6, giving the correct exact area. M1A1.

8(c) 1/2

Correct cosine rule set-up earns M1. It jumps to the given answer without showing $AB^2 = 27$, so A0.

Fix: in a 'show that' include the intermediate value ($AB^2 = 27$)

8(d) 0/5

Triangle ABC is omitted entirely, with no sine rule or area attempt, so all marks are lost. The answer should be about 43.

Fix: total area must include triangle ABC (sine rule for angle)

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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

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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.

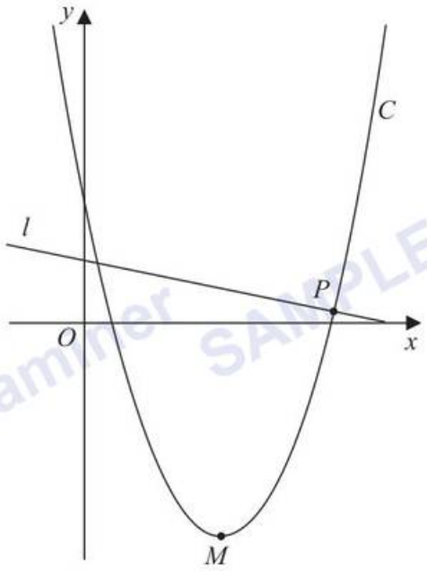


Figure 3

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

Correct completed square form. B1M1A1.

9(b) 1/2

The y-coordinate −28 is correct (B1). The x-coordinate should be +10, so B0.

Fix: minimum of $a(x+b)^2+c$ is at $x = -b$

9(c)(i) 4/4

Tangent gradient 8 used correctly, giving (18, 4). B1M1A1A1.

9(c)(i) 2/2

Correct substitution and value. dM1A1.

9(d) 2/3

Two correct inequalities (B1B1). The boundary $x \geq 10$ is missing, so the final B0.

Fix: include the vertical boundary line $x \geq 10$

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Question 9 continued

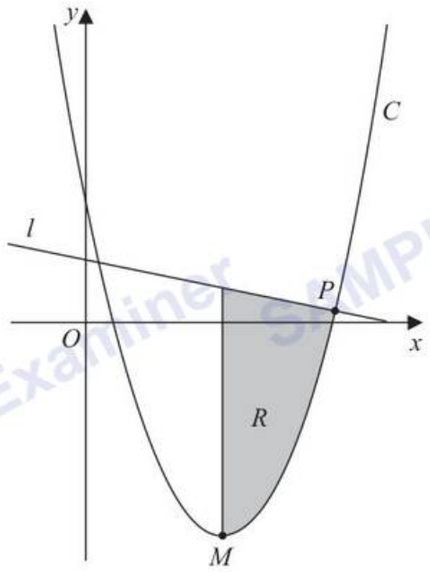


Figure 4

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

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

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

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

b) $-10, -28$

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

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

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Question 9 continued

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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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