Marked by: Chief Examiner

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: 45/75

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 45/75

Cover page. Marking starts on page 2.

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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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Sample script · whole paper 45/75

Question 1 3/6

1(a) 3/3

Correct derivative with all three terms simplified on one line: M1 A1 A1.

1(b) 0/3

The gradient was found by substituting x = 2 into y rather than into dy/dx, so M0; the dependent dM1 and A1 cannot be awarded.

Fix: tangent gradient comes from dy/dx at the point, not from 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

Correct derivative with all three terms simplified on one line: M1 A1 A1.

1(b) 0/3

The gradient was found by substituting x = 2 into y rather than into dy/dx, so M0; the dependent dM1 and A1 cannot be awarded.

Fix: tangent gradient comes from dy/dx at the point, not from 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 values correct: B1 B1.

2(b) 4/5

M1 A1 for splitting into terms with two correct (first two); M1 for raising powers; A1 for two correct integrated terms; final A0 since 32x^0.5 lost the /5 (should give 64/15) and −3x^{-1/2} integrates to −6√x not −3√x.

Fix: divide every term by the denominator; dividing by a fractional power when integrating

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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 values correct: B1 B1.

2(b) 4/5

M1 A1 for splitting into terms with two correct (first two); M1 for raising powers; A1 for two correct integrated terms; final A0 since 32x^0.5 lost the /5 (should give 64/15) and −3x^{-1/2} integrates to −6√x not −3√x.

Fix: divide every term by the denominator; dividing by a fractional power when integrating

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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: M1 A1 A1.

3(b) 1/2

M1 for correct rearrangement using their p and q; A0 because the answer was left as 47/6 and not given to one decimal place (7.8) as required.

Fix: give the answer in the form requested (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: M1 A1 A1.

3(b) 1/2

M1 for correct rearrangement using their p and q; A0 because the answer was left as 47/6 and not given to one decimal place (7.8) as required.

Fix: give the answer in the form requested (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

M1 for cancelling x to reach a quadratic and dM1 for using the quadratic formula on their quadratic; but the quadratic is wrong (should be $2x^2 + x - 15$), $x = 0$ is lost and no correct roots found, so B0 A0.

Fix: expand carefully; cancelling x loses the root x = 0

4(b) 0/2

No exact positive solution from (a) was available and the decimal value with no shown method for the fractional power cannot score; M0 A0.

Fix: link y^{2/3} to the exact root and apply the 3/2 power exactly

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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

M1 for cancelling x to reach a quadratic and dM1 for using the quadratic formula on their quadratic; but the quadratic is wrong (should be $2x^2 + x - 15$), $x = 0$ is lost and no correct roots found, so B0 A0.

Fix: expand carefully; cancelling x loses the root x = 0

4(b) 0/2

No exact positive solution from (a) was available and the decimal value with no shown method for the fractional power cannot score; M0 A0.

Fix: link y^{2/3} to the exact root and apply the 3/2 power exactly

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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

M1 A1 A1 for correct integration; dM1 for substituting (9, 8) to find c; A0 as the −4x term was evaluated with 6 instead of 9 giving c = −107/2 instead of −83/2.

Fix: substitute the same x-value into every term when finding c

5(b) 1/4

M1 for evaluating f'(9) = 3; dM0 as no negative reciprocal was taken (tangent gradient used for the normal), M0 A0 as no normal line or y-intercept coordinates found.

Fix: normal gradient is −1/f'(9), not f'(9)

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Question 5 continued

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Question 5 (continued) 5/9

5(a) 4/5

M1 A1 A1 for correct integration; dM1 for substituting (9, 8) to find c; A0 as the −4x term was evaluated with 6 instead of 9 giving c = −107/2 instead of −83/2.

Fix: substitute the same x-value into every term when finding c

5(b) 1/4

M1 for evaluating f′(9) = 3; dM0 as no negative reciprocal was taken (tangent gradient used for the normal), M0 A0 as no normal line or y-intercept coordinates found.

Fix: normal gradient is −1/f′(9), not f′(9)

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Question 5 continued

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Question 5 (continued) 5/9

5(a) 4/5

M1 A1 A1 for correct integration; dM1 for substituting (9, 8) to find c; A0 as the −4x term was evaluated with 6 instead of 9 giving c = −107/2 instead of −83/2.

Fix: substitute the same x-value into every term when finding c

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M1 for evaluating f′(9) = 3; dM0 as no negative reciprocal was taken (tangent gradient used for the normal), M0 A0 as no normal line or y-intercept coordinates found.

Fix: normal gradient is −1/f′(9), not f′(9)

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Question 5 continued

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Question 5 (continued) 5/9

5(a) 4/5

M1 A1 A1 for correct integration; dM1 for substituting (9, 8) to find c; A0 as the −4x term was evaluated with 6 instead of 9 giving c = −107/2 instead of −83/2.

Fix: substitute the same x-value into every term when finding c

5(b) 1/4

M1 for evaluating f′(9) = 3; dM0 as no negative reciprocal was taken (tangent gradient used for the normal), M0 A0 as no normal line or y-intercept coordinates found.

Fix: normal gradient is −1/f′(9), not f′(9)

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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.

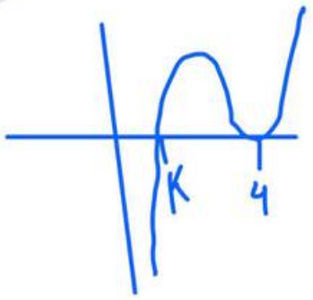
(5)

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

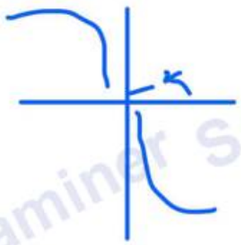
$$(2x - k)(x + 4)^2 = \frac{k}{x^2}$$

(1)

i)



ii)



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Question 6 — 2/6

6(a)(i) 1/3

B1 for a positive cubic with max and min; B0 as the crossing should be k/2 and the turning point should be at x = −4 (left of the y-axis); B0 as the y-intercept −16k is not shown.

Fix: roots from factors: 2x − k = 0 gives k/2, (x+4)² gives a touch at x = −4; y-intercept from x = 0

6(a)(i) 1/2

B1 for an acceptable branch in the second quadrant; B0 because the second branch is in the fourth quadrant (k/x^2 is positive for all x so both branches are above the x-axis).

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

6(b) 0/1

Incorrect: with correct sketches the graphs intersect once so there is one root; also the graphs in (a) were not correct, so B0.

Fix: number of roots = number of intersections of the two 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) 2/6

6(a)(i) 1/3

B1 for a positive cubic with max and min; B0 as the crossing should be k/2 and the turning point should be at x = −4 (left of the y-axis); B0 as the y-intercept −16k is not shown.

Fix: roots from factors: 2x − k = 0 gives k/2, $(x+4)^2$ gives a touch at x = −4; y-intercept from x = 0

6(a)(i) 1/2

B1 for an acceptable branch in the second quadrant; B0 because the second branch is in the fourth quadrant (k/x^2 is positive for all x so both branches are above the x-axis).

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

6(b) 0/1

Incorrect: with correct sketches the graphs intersect once so there is one root; also the graphs in (a) were not correct, so B0.

Fix: number of roots = number of intersections of the two graphs

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7.

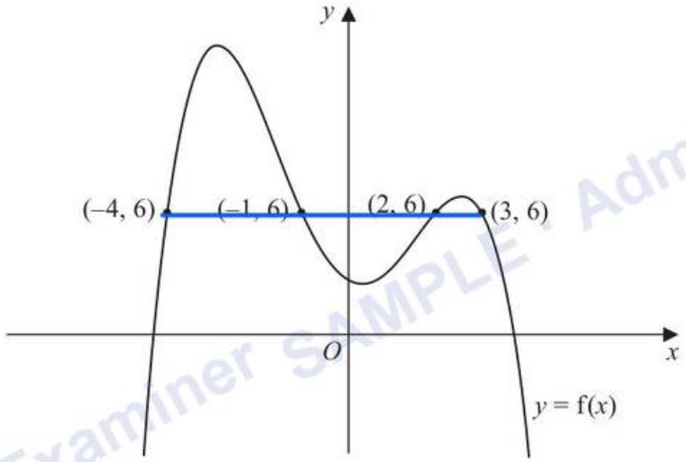


Figure 1

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 scheme requires inequalities in terms of x; verbal description without x inequalities does not score M1/A1/B1.

Fix: write ranges as inequalities in x, e.g. −1 < x < 2

7(b) 1/1

Correct largest solution x = 1.5: B1.

7(c)(i) 3/3

Correct reflection shape and all four transformed coordinates: B1 B1 B1.

7(c)(i) 0/1

Must be −3 □ x □ −2 in terms of x with inclusive inequalities; a verbal statement does not score B1.

Fix: state the set as an inequality in x with correct (inclusive) signs

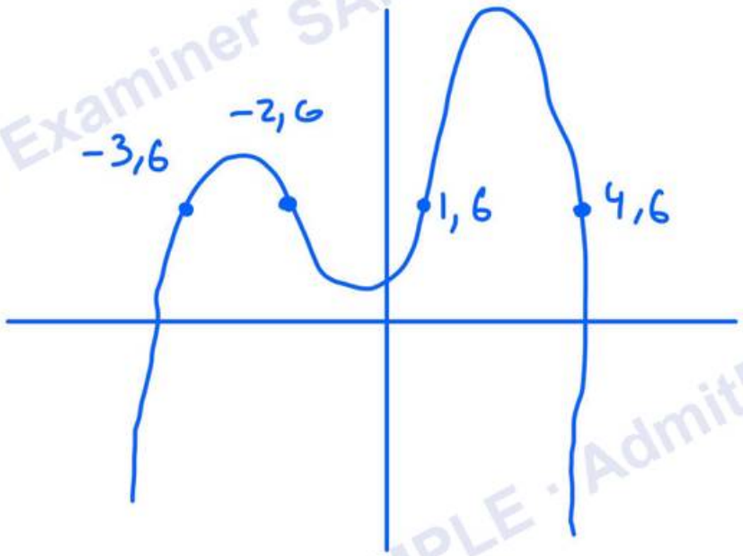
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Question 7 continued

ii) between −3 and −2

( )

i)



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Question 7 (continued) 4/8

7(a) 0/3

The scheme requires inequalities in terms of x; verbal description without x inequalities does not score M1/A1/B1.

Fix: write ranges as inequalities in x, e.g. −1 < x < 2

7(b) 1/1

Correct largest solution x = 1.5: B1.

7(c)(i) 3/3

Correct reflection shape and all four transformed coordinates: B1 B1 B1.

7(c)(i) 0/1

Must be −3 □ x □ −2 in terms of x with inclusive inequalities; a verbal statement does not score B1.

Fix: state the set as an inequality in x with correct (inclusive) signs

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Question 7 continued

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Question 7 (continued) 4/8

7(a) 0/3

The scheme requires inequalities in terms of x; verbal description without x inequalities does not score M1/A1/B1.

Fix: write ranges as inequalities in x, e.g. −1 < x < 2

7(b) 1/1

Correct largest solution x = 1.5: B1.

7(c)(i) 3/3

Correct reflection shape and all four transformed coordinates: B1 B1 B1.

7(c)(i) 0/1

Must be −3 □ x □ −2 in terms of x with inclusive inequalities; a verbal statement does not score B1.

Fix: state the set as an inequality in x with correct (inclusive) signs

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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 scheme requires inequalities in terms of x; verbal description without x inequalities does not score M1/A1/B1.

Fix: write ranges as inequalities in x, e.g. −1 < x < 2

7(b) 1/1

Correct largest solution x = 1.5: B1.

7(c)(i) 3/3

Correct reflection shape and all four transformed coordinates: B1 B1 B1.

7(c)(i) 0/1

Must be −3 □ x □ −2 in terms of x with inclusive inequalities; a verbal statement does not score B1.

Fix: state the set as an inequality in x with correct (inclusive) signs

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8.

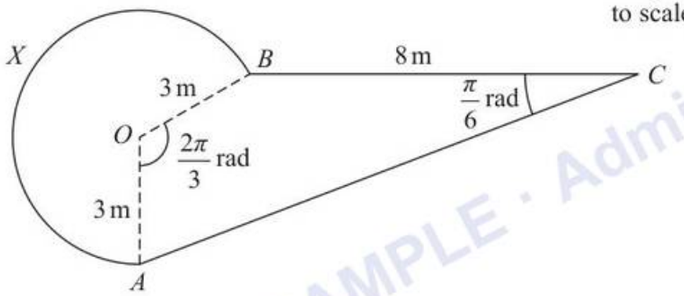


Figure 2

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

Reflex angle found (B1), sector formula used (M1), exact 6π (A1).

8(a)(i) 1/2

M1 for the arc length 4π; A0 because the two radii were not added to give the perimeter 4π + 6.

Fix: perimeter of a sector = arc + two radii

8(b) 2/2

Valid ½ab sinC using AB = 3√3, OA = 3 and angle π/6 giving the correct exact area: M1 A1.

8(c) 1/2

M1 for correct cosine rule; A0 because for a show-that the intermediate value ($c^2 = 27$ or $c = \sqrt{27}$) must be seen before $3\sqrt{3}$.

Fix: show-that proofs need the intermediate step, e.g. $AB^2 = 27$

8(d) 0/5

Triangle ABC was never attempted (no sine rule / angle BAC / area ABC), so no method marks; answer 23 is incorrect.

Fix: total area includes triangle ABC: need angle BAC via sine rule then ½·AB·BC·sin(ABC)

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) 7/14

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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.

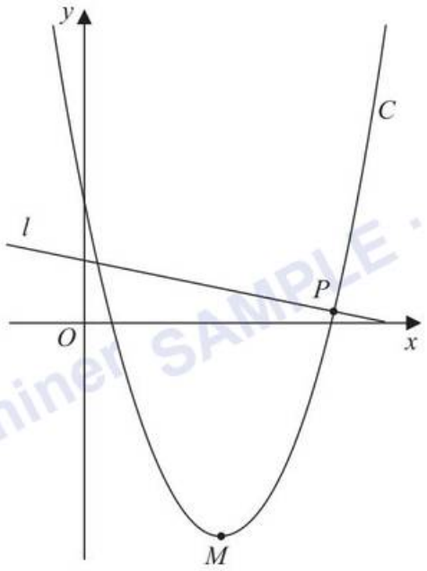


Figure 3

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

Correct completed square form with a = ½, b = −10, c = −28: B1 M1 A1.

9(b) 1/2

B1 for the y-coordinate −28; B0 as the x-coordinate should be 10 (from $(x - 10)^2$), not −10.

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

9(c)(i) 4/4

Tangent gradient 8 used (B1), derivative set equal to 8 (M1), x = 18 and y = 4 (A1 A1).

9(c)(i) 2/2

Substituted P into the line and found k = 25/4: dM1 A1.

9(d) 2/3

B1ft B1ft for the curve and line inequalities (l allowed in terms of k); B0 as the inequality x □ 10 for the vertical line through M is missing.

Fix: region bounded by a vertical line needs an x-inequality too

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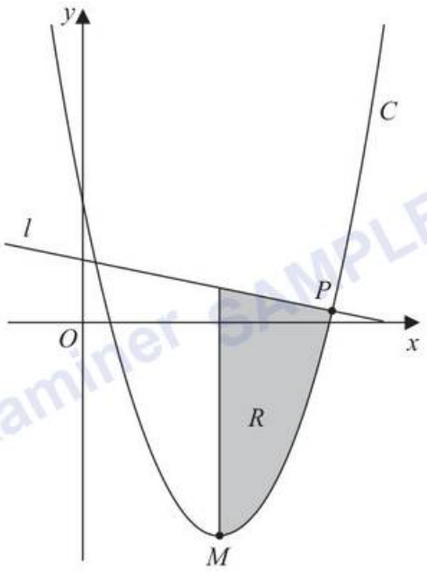


Figure 4

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

9(a) 3/3

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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) 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

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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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