Marked by: Assistant 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

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	4 / 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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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.

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

Correct differentiation of all three terms fully simplified.

1(b) 0/3

Substituted x = 2 into y instead of dy/dx to find the gradient, so M0, dM0, A0.

Fix: tangent gradient requires substituting into 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

Correct differentiation of all three terms fully simplified.

1(b) 0/3

Substituted x = 2 into y instead of dy/dx to find the gradient, so M0, dM0, A0.

Fix: tangent gradient requires substituting into 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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Sample script · whole paper 45/75

Question 2 **6/7**

2(a) 2/2

Correct expansion and values of a and b found.

2(b) 4/5

Awarded M1 for split powers, A1 for at least two correct unsimplified terms, M1 for integration method, A1 for two correct integrated terms. Final A1 withheld due to incorrect coefficients on the last two terms.

Fix: dividing all terms by 5 and integrating negative fractional powers correctly

Question 2 continued

(Total for Question 2 is 7 marks)

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Question 2 (continued) 6/7

2(a) 2/2

Correct expansion and values of a and b found.

2(b) 4/5

Awarded M1 for split powers, A1 for at least two correct unsimplified terms, M1 for integration method, A1 for two correct integrated terms. Final A1 withheld due to incorrect coefficients on the last two terms.

Fix: dividing all terms by 5 and integrating negative fractional powers correctly

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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 formed and solved to find p = 0.3 and q = 0.15 (3/20).

3(b) 1/2

Correct method to solve for T, but answer was left as an exact fraction rather than rounded to 1 decimal place (7.8).

Fix: rounding to required 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 formed and solved to find p = 0.3 and q = 0.15 (3/20).

3(b) 1/2

Correct method to solve for T, but answer was left as an exact fraction rather than rounded to 1 decimal place (7.8).

Fix: rounding to required 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 2/6

4(a) 2/4

Earned M1 for reducing to a 3-term quadratic and dM1 for using the quadratic formula. Withheld B1 and A1 as x = 0 was lost and an algebraic slip led to incorrect roots.
Fix: factorising out x instead of dividing by x; expanding brackets accurately

4(b) 0/2

Used rounded decimals and did not show an algebraic method dealing with the fractional power as required without calculator technology.
Fix: solving equations with fractional indices without decimals

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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

Earned M1 for reducing to a 3-term quadratic and dM1 for using the quadratic formula. Withheld B1 and A1 as x = 0 was lost and an algebraic slip led to incorrect roots.

Fix: factorising out x instead of dividing by x; expanding brackets accurately

4(b) 0/2

Used rounded decimals and did not show an algebraic method dealing with the fractional power as required without calculator technology.

Fix: solving equations with fractional indices without decimals

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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

M1, A1, A1 earned for integration. dM1 earned for attempting to substitute (9, 8) to find c, but a slip substituting 6 instead of 9 led to an incorrect value of c, losing the final A1.

Fix: careful substitution of coordinates

5(b) 1/4

M1 earned for evaluating f'(9) = 3. Did not find the normal gradient (negative reciprocal) and did not find the y-intercept coordinates.

Fix: normal gradient is the negative reciprocal of tangent gradient

Question 5 continued

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Question 5 (continued) 5/9

5(a) 4/5

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Question 5 continued

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

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Question 5 (continued) 5/9

5(a) 4/5

M1, A1, A1 earned for integration. dM1 earned for attempting to substitute (9, 8) to find c, but a slip substituting 6 instead of 9 led to an incorrect value of c, losing the final A1.

Fix: careful substitution of coordinates

5(b) 1/4

M1 earned for evaluating f'(9) = 3. Did not find the normal gradient (negative reciprocal) and did not find the y-intercept coordinates.

Fix: normal gradient is the negative reciprocal of 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

M1, A1, A1 earned for integration. dM1 earned for attempting to substitute (9, 8) to find c, but a slip substituting 6 instead of 9 led to an incorrect value of c, losing the final A1.

Fix: careful substitution of coordinates

5(b) 1/4

M1 earned for evaluating f'(9) = 3. Did not find the normal gradient (negative reciprocal) and did not find the y-intercept coordinates.

Fix: normal gradient is the negative reciprocal of 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.

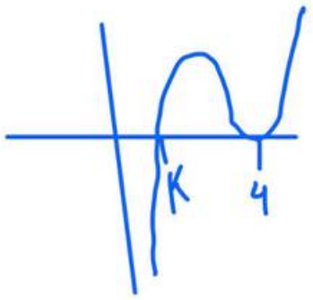
(5)

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

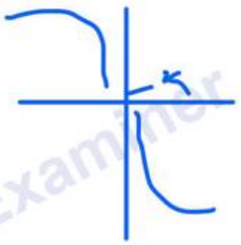
$$(2x - k)(x + 4)^2 = \frac{k}{x^2}$$

(1)

i)



ii)



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Sample script · whole paper 45/75

Question 6 2/6

6(a)(i) 1/3

B1 awarded for positive cubic shape with local max and min. Both axis intersection/touch point marks lost (touch point placed at +4 instead of -4, y-intercept omitted).

Fix: repeated root corresponds to a turning point touching the axis at the correct sign

6(a)(i) 1/2

B1 awarded for curve of correct shape in quadrant 2. The second B1 lost because the other branch was drawn in quadrant 4 instead of quadrant 1.

Fix: shape and quadrants of y = k/x^2 (always positive for k > 0)

6(b) 0/1

Mark is dependent on correct graphs in (a) and requires 1 root.

Fix: interpreting intersections of curves for number of roots

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 awarded for positive cubic shape with local max and min. Both axis intersection/touch point marks lost (touch point placed at +4 instead of -4, y-intercept omitted).

Fix: repeated root corresponds to a turning point touching the axis at the correct sign

6(a)(i) 1/2

B1 awarded for curve of correct shape in quadrant 2. The second B1 lost because the other branch was drawn in quadrant 4 instead of quadrant 1.

Fix: shape and quadrants of y = k/x^2 (always positive for k > 0)

6(b) 0/1

Mark is dependent on correct graphs in (a) and requires 1 root.

Fix: interpreting intersections of curves for number of roots

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7.

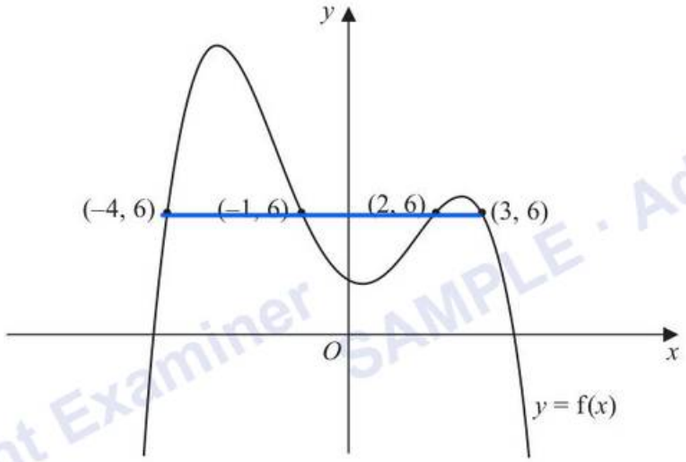


Figure 1

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

Mark scheme explicitly requires inequalities in terms of x, not descriptions in words.

Fix: writing solution sets as inequalities in terms of the variable

7(b) 1/1

Correct value of 1.5.

7(c)(i) 3/3

Correct reflection shape and all four coordinates accurately transformed and labelled.

7(c)(i) 0/1

Must be written in terms of x using inclusive inequalities (-3 <= x <= -2).

Fix: inclusive inequality notation in terms of x

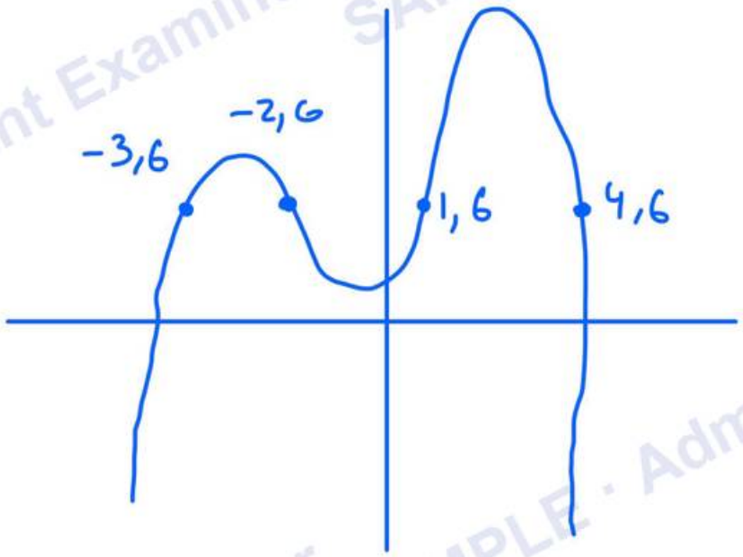
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Question 7 continued

ii) between -3 and -2

( )

i)



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Question 7 (continued) 4/8

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Question 7 continued

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Question 7 (continued) 4/8

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7(c)(i) 3/3

Correct reflection shape and all four coordinates accurately transformed and labelled.

7(c)(i) 0/1

Must be written in terms of x using inclusive inequalities (-3 <= x <= -2).

Fix: inclusive inequality notation in terms of x

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Question 7 continued

(Total for Question 7 is 8 marks)

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Question 7 (continued) 4/8

7(a) 0/3

Mark scheme explicitly requires inequalities in terms of x, not descriptions in words.

Fix: writing solution sets as inequalities in terms of the variable

7(b) 1/1

Correct value of 1.5.

7(c)(i) 3/3

Correct reflection shape and all four coordinates accurately transformed and labelled.

7(c)(i) 0/1

Must be written in terms of x using inclusive inequalities (-3 <= x <= -2).

Fix: inclusive inequality notation in terms of x

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8.

Diagram **NOT** to scale

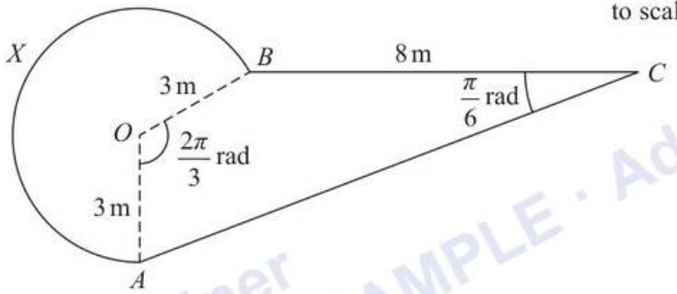


Figure 2

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

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

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

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

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

(5)

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

(2)

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

(2)

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

(5)

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

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

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

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Sample script · whole paper 45/75

Question 8 — 7/14

8(a)(i) 3/3

Correct angle found and exact sector area calculated.

8(a)(i) 1/2

M1 earned for finding the arc length, but A1 lost as the two radii were not added to find the total perimeter.

Fix: perimeter of a sector includes the two bounding radii

8(b) 2/2

Valid method used to find the exact area of triangle AOB.

8(c) 1/2

M1 awarded for cosine rule attempt, but the unsimplified intermediate evaluation (e.g. c^2 = 27 or c = sqrt(27)) was omitted in a 'show that' question.

Fix: full intermediate steps required in 'show that' questions

8(d) 0/5

Completely omitted triangle ABC and simply added the sector to triangle AOB.

Fix: identifying all components of a 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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Sample script · whole paper 45/75

Question 8 (continued) 7/14

8(a)(i) 3/3

Correct angle found and exact sector area calculated.

8(a)(i) 1/2

M1 earned for finding the arc length, but A1 lost as the two radii were not added to find the total perimeter.

Fix: perimeter of a sector includes the two bounding radii

8(b) 2/2

Valid method used to find the exact area of triangle AOB.

8(c) 1/2

M1 awarded for cosine rule attempt, but the unsimplified intermediate evaluation (e.g. c^2 = 27 or c = sqrt(27)) was omitted in a 'show that' question.

Fix: full intermediate steps required in 'show that' questions

8(d) 0/5

Completely omitted triangle ABC and simply added the sector to triangle AOB.

Fix: identifying all components of a composite shape

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Question 8 continued

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Sample script · whole paper 45/75

Question 8 (continued) 7/14

8(a)(i) 3/3

Correct angle found and exact sector area calculated.

8(a)(i) 1/2

M1 earned for finding the arc length, but A1 lost as the two radii were not added to find the total perimeter.

Fix: perimeter of a sector includes the two bounding radii

8(b) 2/2

Valid method used to find the exact area of triangle AOB.

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Question 8 continued

(Total for Question 8 is 14 marks)

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Sample script · whole paper 45/75

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9.

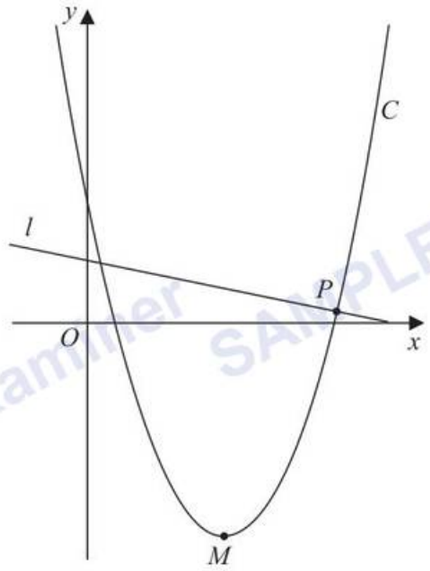


Figure 3

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 expression obtained by completing the square.

9(b) 1/2

B1ft earned for y = -28, but x-coordinate was written as -10 instead of +10.

Fix: minimum point of a(x - h)^2 + k is at x = h, not -h

9(c)(i) 4/4

Correctly identified tangent gradient 8, solved dy/dx = 8 to find x = 18 and y = 4.

9(c)(i) 2/2

Correct method and exact answer for k.

9(d) 2/3

Two correct inequalities given (B1ft, B1ft), but missed the boundary x >= 10 from the line through M parallel to the y-axis.

Fix: identifying all bounding lines defining a shaded region

Question 9 continued

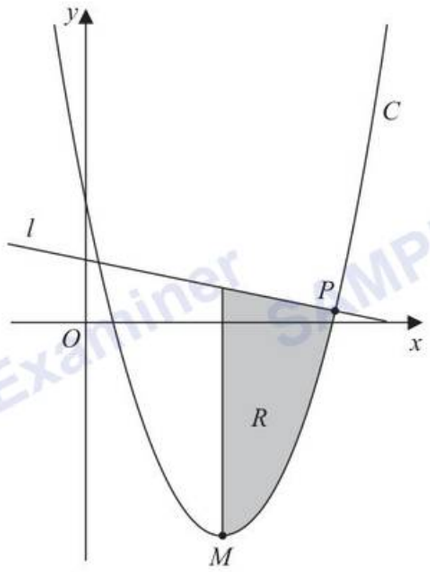


Figure 4

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

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

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

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

b) $-10, -28$

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Sample script · whole paper 45/75

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

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(Total for Question 9 is 14 marks)

TOTAL FOR PAPER IS 75 MARKS

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

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