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INTERNATIONAL A LEVEL MATHEMATICS • PURE 2

Pure Mathematics 2

Exam Questions by Topic

Pearson Edexcel International Advanced Level (WMA12/01) • Calculator allowed

Multi-step exam questions at the difficulty of the real WMA12 paper, with a full mark scheme

Chapters (tap a chapter to jump to it)	Qs	Marks	Page	My score
1 Algebraic Methods Algebraic fractions, the factor and remainder theorems, proof	10	66	own PDF	
2 Coordinate Geometry in the (x, y) Plane Equations of circles, tangents, chords and intersections	10	68	own PDF	
3 Exponentials and Logarithms Laws of logarithms, exponential equations, modelling	10	68	own PDF	
4 The Binomial Expansion Expanding $(a + bx)^n$, coefficients and approximations	10	65	own PDF	
5 Sequences and Series Arithmetic and geometric series, sigma notation, recurrence	10	69	own PDF	
6 Trigonometric Identities and Equations $\tan \theta = \frac{\sin \theta}{\cos \theta}$, $\sin^2 \theta + \cos^2 \theta = 1$, solving equations	10	66	own PDF	
7 Differentiation Increasing and decreasing functions, stationary points, optimisation	10	67	2	
8 Integration Definite integrals, areas under curves, the trapezium rule	10	67	own PDF	

[Full mark scheme](#)

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7

CHAPTER 7 • KEY SKILLS

Differentiation

Specification P2: 7.1 • 10 questions • 67 marks • about 80 minutes

1 Stationary points

Solve $\frac{dy}{dx} = 0$, then substitute each x into y (not into $\frac{dy}{dx}$).

2 Nature of a stationary point

$\frac{d^2y}{dx^2} < 0$: maximum. $\frac{d^2y}{dx^2} > 0$: minimum. Give the value and a conclusion.

3 Increasing and decreasing

Increasing where $f'(x) > 0$; decreasing where $f'(x) < 0$. Solve the quadratic inequality.

4 Increasing for all x

Complete the square:
 $f'(x) = a(x+p)^2 + q$ with $a, q > 0$ means
 $f'(x) > 0$ for all x .

5 Powers of x first

Write roots and fractions as powers before differentiating, e.g. $\frac{8}{x^2} = 8x^{-2}$.

6 Forming the expression

Use the constraint (fixed volume, perimeter or area) to remove the second variable.

7 Maximum and minimum values

Solve $\frac{dV}{dx} = 0$ and substitute back into V , with units.

8 Practical domain

Reject values that make a length negative or zero, and say why.

9 Using stationary points

Stationary points fix the shape of a sketch and the values of k for which $f(x) = k$ has a given number of solutions.

Skills map every skill above is tested at least once; interleaved skills come from GCSE or other chapters

Skill	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Marks	6	4	5	4	5	8	8	8	9	10
1 Stationary points	•		•		•	•	•	•	•	•
2 Nature of a stationary point	•		•			•	•	•	•	•
3 Increasing and decreasing		•							•	
4 Increasing for all x				•						
5 Powers of x first			•				•			
6 Forming the expression						•	•	•		
7 Maximum and minimum values						•	•	•		
8 Practical domain						•				
9 Using stationary points					•					•
Interleaved: quadratics, completing the square, inequalities (P1)		•		•					•	•
Interleaved: circle measures and indices (P1)			•				•	•		
Interleaved: factor theorem, sketching cubics (P2 Ch 1, P1)					•				•	•

Exam difficulty. Questions 1 to 5 check each skill on its own. Questions 6 to 10 are multi-step questions built like the last questions on a real WMA12 paper, where one part leads into the next and skills from different topics are combined.

Must learn. “Justify” or “show that it is a maximum” needs the second derivative’s value (or sign) *and* a conclusion. In context, give the maximum or minimum value, not just the value of x .



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1. The curve C has equation $y = 2x^3 - 9x^2 + 12x + 1$

(a) Find the coordinates of the stationary points of C .

(4)

(b) Use $\frac{d^2y}{dx^2}$ to determine the nature of each stationary point.

(2)

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Question 1 continued

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(Total for Question 1 is 6 marks)



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2.

$$f(x) = x^3 - 6x^2 - 15x + 2$$

Find the set of values of x for which $f(x)$ is decreasing.

(4)

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(Total for Question 2 is 4 marks)**Join students already acing their exams.**Book your FREE lesson at www.eclassroom.org.uk

3. The curve C has equation $y = 2x^{\frac{3}{2}} - 12x + 7$, $x > 0$

(a) Find the coordinates of the stationary point of C .

(3)

(b) Determine the nature of this stationary point, giving a reason for your answer.

(2)

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Question 3 continued

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4.

$$f(x) = x^3 + 3x^2 + 5x - 4$$

Show that $f(x)$ is an increasing function for all real values of x .

(4)

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(Total for Question 4 is 4 marks)**Join students already acing their exams.**Book your FREE lesson at www.eclassroom.org.uk

5.

$$f(x) = x^3 - 3x^2 - 9x$$

(a) Find the coordinates of the stationary points of the curve with equation $y = f(x)$. (3)

(b) Sketch the curve with equation $y = f(x)$, showing the coordinates of the stationary points and of the point where the curve crosses the y -axis. (2)

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Question 5 continued

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(Total for Question 5 is 5 marks)



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6.

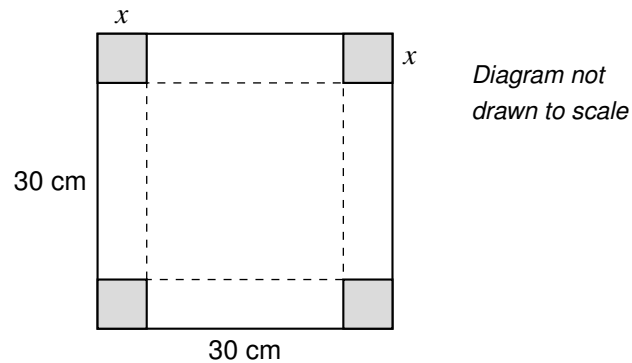
**Figure 1**

Figure 1 shows a square sheet of card of side 30 cm. A square of side x cm is cut from each corner and the sides are folded up along the dashed lines to make an open box.

- (a) Show that the volume, V cm³, of the box is given by

$$V = 4x^3 - 120x^2 + 900x$$

(2)

- (b) Use calculus to find the value of x for which V is stationary, explaining why any other value must be rejected.

(4)

- (c) Find the maximum volume of the box, and justify that it is a maximum.

(2)

Question 6 continued

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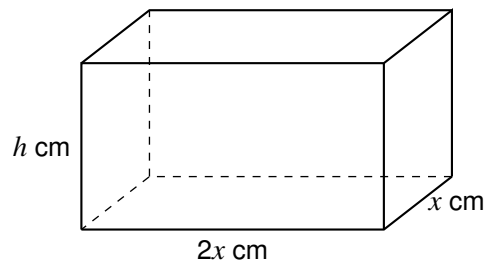
(Total for Question 6 is 8 marks)



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7.

**Figure 2**

A closed box in the shape of a cuboid has a base of length $2x$ cm and width x cm, and a height of h cm, as shown in Figure 2. The volume of the box is 72 cm^3

- (a) Show that the total surface area, $S \text{ cm}^2$, of the box is given by

$$S = 4x^2 + \frac{216}{x}$$

(3)

- (b) Use calculus to find the minimum value of S .

(3)

- (c) Justify that the value of S found in part (b) is a minimum.

(2)

Question 7 continued

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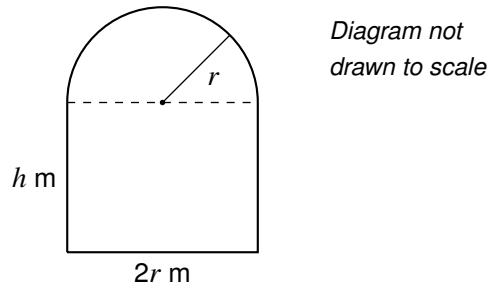
**Figure 3**

Figure 3 shows the design for a window. It is a rectangle of width $2r$ metres and height h metres, with a semicircle of radius r metres on top. The perimeter of the window is 10 m.

- (a) Show that the area, $A \text{ m}^2$, of the window is given by

$$A = 10r - \left(2 + \frac{\pi}{2}\right)r^2 \quad (3)$$

- (b) Use calculus to find the exact value of r for which A is a maximum, and show that the maximum area is $\frac{50}{4 + \pi} \text{ m}^2$

(4)

- (c) Justify that this value of A is a maximum.

(1)



Question 8 continued

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9.

$$f(x) = ax^3 + bx^2 - 12x + 5$$

where a and b are constants. The curve with equation $y = f(x)$ has a stationary point at $(1, -2)$.

(a) Find the value of a and the value of b .

(4)

(b) Find the coordinates of the other stationary point, and determine the nature of both stationary points.

(3)

(c) Find the set of values of x for which $f(x)$ is increasing.

(2)

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Question 9 continued

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Question 9 continued

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10. In this question you must show all stages of your working.

The curve C has equation $y = x^3 - 6x^2 + 9x + 1$

- (a) Find the coordinates of the stationary points of C and determine their nature. (5)
- (b) The tangent to C at the maximum point meets C again at the point P . Using algebra, find the coordinates of P . (3)
- (c) Find the set of values of k for which the equation $x^3 - 6x^2 + 9x + 1 = k$ has three distinct real solutions. (2)

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Question 10 continued

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Question 10 continued

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(Total for Question 10 is 10 marks)

TOTAL FOR CHAPTER 7 IS 67 MARKS

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