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INTERNATIONAL A LEVEL MATHEMATICS • PURE 3

Pure Mathematics 3

Exam Questions by Topic

Pearson Edexcel International Advanced Level (WMA13/01) • Calculator allowed

Multi-step exam questions at the difficulty of the real WMA13 paper, with a full mark scheme

Chapters (tap a chapter to jump to it)	Qs	Marks	Page	My score
1 Algebraic Methods Algebraic fractions, improper fractions and algebraic division	10	69	own PDF	
2 Functions and Graphs Modulus, composite and inverse functions, transformations	10	76	2	
3 Trigonometric Functions sec, cosec, cot, identities, inverse trigonometric functions	10	72	own PDF	
4 Trigonometric Addition Formulae Addition and double-angle formulae, $R\cos(\theta \pm \alpha)$	10	75	own PDF	
5 Exponentials and Logarithms e^x , $\ln x$, modelling, logarithmic graphs	10	78	own PDF	
6 Differentiation Chain, product and quotient rules, trigonometric and exponential functions	10	76	own PDF	
7 Integration Standard integrals, $f(ax+b)$, trigonometric identities, reverse chain rule	10	77	own PDF	
8 Numerical Methods Locating roots, iteration	10	77	own PDF	

[Full mark scheme](#)

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CHAPTER 2 • KEY SKILLS

2

Functions and Graphs

Specification P3: Functions • 10 questions • 76 marks • about 90 minutes

1 The modulus function $|x| = x$ for $x \geq 0$ and $-x$ for $x < 0$. $y = |ax + b|$ is a V shape with its vertex on the x -axis.**2 Modulus equations**Solve $+(\dots)$ and $-(\dots)$ separately, then check each answer in the original equation. A sketch shows how many solutions.**3 Domain and range**The range of f is the set of outputs for the domain given. Find *both* ends: sketch it.**4 Composite functions** $fg(x) = f(g(x))$: apply g first. Its outputs must lie in the domain of f .**5 Inverse functions**Only one-to-one functions have inverses. Swap x and y , rearrange, write $f^{-1}(x) = \dots$.
Domain of f^{-1} = range of f .**6 $|f(x)|$ and $f(|x|)$** $y = |f(x)|$: reflect the parts below the x -axis upwards. $y = f(|x|)$: reflect the part for $x \geq 0$ in the y -axis.**7 Combined transformations** $y = af(bx + c) + d$: change x in the order " $+c$ then $\div b$ ", and y in the order " $\times a$ then $+d$ ".**8 Points under transformations**Track a point: e.g. $(3, -4)$ on $y = f(x)$ maps to $(5, 1)$ on $y = f(x - 2) + 5$ **9 Parameters in modulus graphs**

Write key points in terms of the constants; substitute known intersections into the correct branch.

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	5	5	5	5	10	10	10	10	10
1 The modulus function		•	•				•		•	
2 Modulus equations		•	•				•	•	•	
3 Domain and range						•	•			•
4 Composite functions					•	•				•
5 Inverse functions						•				
6 $ f(x) $ and $f(x)$	•			•				•		
7 Combined transformations				•				•		
8 Points under transformations	•			•			•			
9 Parameters in modulus graphs			•				•			
Interleaved: algebraic fractions (Chapter 1)						•				•
Interleaved: quadratics, completing the square, surds (P1)					•			•	•	•
Interleaved: inequalities and simultaneous equations (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 WMA13 paper, where one part leads into the next and skills from different topics are combined.**Must learn.** Always give the domain of an inverse function. Write $f^{-1}(x) = \dots$ in terms of x , and check every modulus solution in the original equation.

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1.

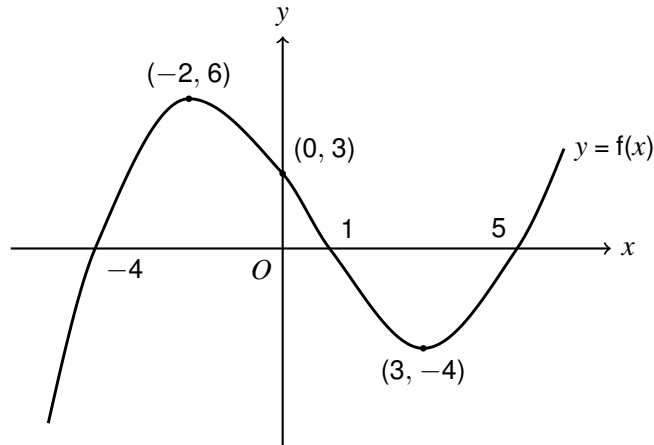
**Figure 1**

Figure 1 shows a sketch of the curve with equation $y = f(x)$. The curve has a maximum point at $(-2, 6)$ and a minimum point at $(3, -4)$, crosses the x -axis at -4 , 1 and 5 , and crosses the y -axis at $(0, 3)$.

On separate diagrams, sketch the curve with equation

(a) $y = |f(x)|$ (3)

(b) $y = f(|x|)$ (3)

On each sketch, show clearly the coordinates of any turning points and of any points where the curve meets or crosses the coordinate axes.



Question 1 continued

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(Total for Question 1 is 6 marks)**Join students already acing their exams.**Book your FREE lesson at www.eclassroom.org.uk

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

Solutions relying on calculator technology are not acceptable.

(a) Solve the equation $|3x - 5| = x + 7$

(3)

(b) Hence find the set of values of x for which $|3x - 5| < x + 7$

(2)

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Question 2 continued

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

Solutions relying on calculator technology are not acceptable.

$$f(x) = |3x + a| + a \quad x \in \mathbb{R}$$

where a is a positive constant.

(a) Sketch the graph of $y = f(x)$, showing, in terms of a , the coordinates of its vertex and of the point where it meets the y -axis.

(2)

(b) Solve, in terms of a , the equation $f(x) = 5a$

(3)

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Question 3 continued

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4. The point $P(3, -4)$ lies on the curve with equation $y = f(x)$.

Find the coordinates of the point, or points, to which P is mapped on the curve with equation

(a) $y = |f(x)| - 2$

(1)

(b) $y = f(|x|) + 1$

(2)

(c) $y = 2f(x + 1)$

(1)

(d) $y = -f(2x)$

(1)

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Question 4 continued

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

Solutions relying on calculator technology are not acceptable.

The functions f and g are defined by

$$f(x) = x^2 - 4x \quad g(x) = 2x + 1 \quad x \in \mathbb{R}$$

(a) Find $fg(x)$ in its simplest form.

(2)

(b) Solve the equation $fg(x) = gf(x)$, giving your answers in simplest surd form.

(3)

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Question 5 continued

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(Total for Question 5 is 5 marks)



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6. The functions f and g are defined by

$$f(x) = \frac{2x+3}{x+1} \quad x \geq 0 \qquad g(x) = x^2 - 1 \quad x \in \mathbb{R}$$

- (a) Find the range of f . (2)
- (b) Find $f^{-1}(x)$, stating its domain. (4)
- (c) Find the exact value of $fg(-2)$. (1)
- (d) Show that the equation $gf(x) = 3$ has no solutions. (3)

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Question 6 continued

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Question 6 continued

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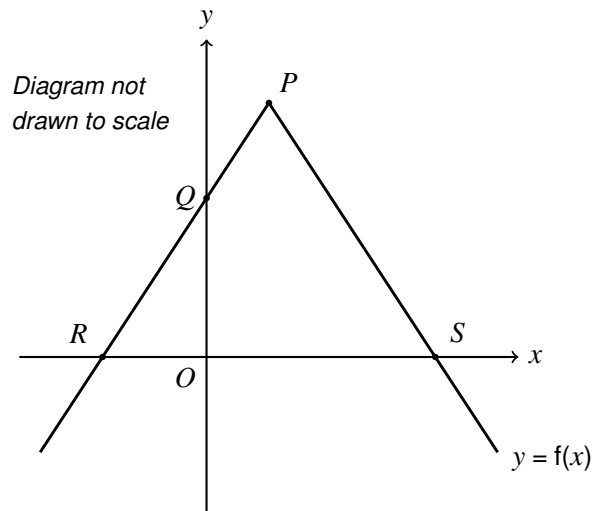


Figure 2

Figure 2 shows a sketch of the graph with equation $y = f(x)$, where

$$f(x) = a - |2x - b|$$

and a and b are positive constants with $a > b$. The graph has a maximum at P , meets the y -axis at Q and meets the x -axis at R and S .

(a) Find, in terms of a and b , the coordinates of

- (i) P
- (ii) Q
- (iii) R and S

(4)

The graph of $y = |x| - 1$ meets the graph of $y = f(x)$ at the points where $x = -2$ and $x = 4$

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

(5)

(c) Hence find the set of values of k for which the equation $f(x) = k$ has exactly two solutions.

(1)



Question 7 continued

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Question 7 continued

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Solutions relying on calculator technology are not acceptable.

(a) Sketch the graph of $y = f(|x|)$, showing the coordinates of the points where it meets the coordinate axes and of its minimum points.

(3)

(2)

(1)

(2)

(2)

Question 8 continued

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Question 8 continued

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9. In this question you must show all stages of your working.**Solutions relying on calculator technology are not acceptable.**

- (a) On the same axes, sketch the graphs of $y = |2x + 3|$ and $y = x^2$, showing the coordinates of any points where the graphs meet the coordinate axes. (3)
- (b) Use algebra to find the coordinates of the points where the two graphs meet. (3)
- (c) Hence solve the inequality $x^2 < |2x + 3|$ (2)
- (d) Solve the equation $|2x + 3| = 3x - 1$, explaining why one of the solutions of your working must be rejected. (2)

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Question 9 continued

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Question 9 continued

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Solutions relying on calculator technology are not acceptable.

$$f(x) = \frac{4}{x+2} \quad x \geq 0 \qquad g(x) = x^2 - 2x \quad x \in \mathbb{R}$$

- (a) Find the range of f . (2)
- (b) Show that $gf(x) = \frac{-8x}{(x+2)^2}$ (2)
- (c) Find the range of gf . (3)
- (d) Solve the equation $gf(x) = -\frac{3}{4}$ (3)

Question 10 continued

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Question 10 continued

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