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INTERNATIONAL A LEVEL MATHEMATICS • PURE 3

Pure Mathematics 3

Exam Questions by Topic: Mark Scheme

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

Every question in the booklet, marked line by line the way an examiner marks it

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	3	
2 Functions and Graphs Modulus, composite and inverse functions, transformations	10	76	own PDF	
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	

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How to use this mark scheme

The same marking rules Pearson examiners use for WMA13.

Mark every line, not just the answer. Method marks are given for a correct method even when the final answer is wrong. If you lost marks, find the *first* line where your working differs from the scheme. That is the thing to fix.

Code	Meaning
M1	Method mark: for knowing a correct method and attempting to apply it. Small slips in the working do not lose this mark.
dM1	Dependent method mark: can only be given if the method mark before it has been given.
A1	Accuracy mark: for a correct answer or line of working. It can only be given if the method mark it depends on has been given.
B1	Independent mark: for a correct result or statement, whatever method was used.
*	The answer is given in the question. Every step must be shown, and the answer must follow from correct working (cso).
cao	Correct answer only.
cso	Correct solution only: no errors anywhere in the working.
ft	Follow through: the mark can be given for correct work using your own earlier (wrong) answer.
oe	Or equivalent: any correct equivalent form is accepted.

“Solutions relying on calculator technology are not acceptable.” When a question says this, a correct final answer with no algebraic working scores **no marks**. The notes under each scheme line say when this applies.



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Chapter 1: Algebraic Methods

Mark scheme. Marks are shown on the right of each line.

Question 1

4 marks

Part	Scheme	Marks
	Factorises: $2x^2 + x - 15 = (2x - 5)(x + 3)$ and $3x^2 - 27 = 3(x - 3)(x + 3)$	M1
	Cancels $(x + 3)$: $\frac{3(x - 3)}{2x - 5}$	A1
	Adds with the common denominator $2x - 5$: $\frac{3x - 9 + 4}{2x - 5}$	M1
	$= \frac{3x - 5}{2x - 5}$ *	A1*
	<i>Losing the factor 3 in $3(x - 3)(x + 3)$ is the common error. Every step must be shown for this printed answer.</i>	(4)
Total for Question 1: 4 marks		

Question 2

5 marks

Part	Scheme	Marks
(a)	Cancels the common factor x : $\frac{2x^3 + 7x^2 + 2x + 2}{x + 3}$	M1
	Divides by $(x + 3)$: quotient $2x^2 + x - 1$	M1
	Remainder 5	A1
	$A = 2, B = 1, C = -1, D = 5$, i.e. $f(x) = 2x^2 + x - 1 + \frac{5}{x + 3}$	A1
	<i>Dividing the quartic by $x^2 + 3x$ directly gives remainder $5x$, and $\frac{5x}{x(x+3)} = \frac{5}{x+3}$: also full marks.</i>	(4)
(b)	$-1 + \frac{5}{x+3} = 0 \Rightarrow x = 2$	B1
		(1)
Total for Question 2: 5 marks		



Question 3

6 marks

Part	Scheme	Marks
(a)	$x^2 + x - 2 = (x+2)(x-1)$ is the common denominator	B1
	$\frac{3(x-1) + 2(x+2) - (7x-1)}{(x+2)(x-1)}$	M1
	$= \frac{-2x+2}{(x+2)(x-1)} = \frac{-2(x-1)}{(x+2)(x-1)}$	A1
	$\frac{-2}{x+2}$, so $a = -2$, $b = 2$	A1
		(4)
(b)	$-2 = (x+1)(x+2) \Rightarrow x^2 + 3x + 4 = 0$	M1
	Discriminant $9 - 16 = -7 < 0$, so no real solutions *	A1*
		(2)
Total for Question 3: 6 marks		

Question 4

5 marks

Part	Scheme	Marks
(a)	Divides by $(2x+3)$: quotient $3x + \dots$	M1
	Quotient $3x - 2$, remainder 2	A1
	$f(x) = 3x - 2 + \frac{2}{2x+3}$	A1
	<i>The final mark needs the expression written out in full.</i>	
		(3)
(b)	$\frac{2}{2x+3} > 0$	M1
	$x > -\frac{3}{2}$	A1
		(2)
Total for Question 4: 5 marks		



Question 5

5 marks

Part	Scheme	Marks
	$x^2 - x - 2 = (x - 2)(x + 1)$; multiplies through by it: $3x(x + 1) - 4(x - 2) = 12$ $3x^2 - x - 4 = 0$ $(3x - 4)(x + 1) = 0$ $x = \frac{4}{3}$ or $x = -1$ $x = -1$ makes the denominators $x + 1$ and $x^2 - x - 2$ zero, so it is rejected: $x = \frac{4}{3}$	M1 A1 M1 A1 A1 (5)
Total for Question 5: 5 marks		

Question 6

9 marks

Part	Scheme	Marks
(a)	$1 + 3 - 4$ $= 0$, so $(x - 1)$ is a factor *	M1 A1* (2)
(b)	$x^3 + 3x^2 - 4 = (x - 1)(x^2 + 4x + 4)$ $= (x - 1)(x + 2)^2$ $x^2 + x - 2 = (x - 1)(x + 2)$ $f(x) = \frac{(x - 1)(x + 2)^2}{(x - 1)(x + 2)} = x + 2$ *	M1 A1 B1 A1* (4)
(c)	$y = x + 2$ is a straight line, but f is not defined at $x = 1$ and $x = -2$ Substitutes into $y = x + 2$ $(1, 3)$ and $(-2, 0)$	B1 M1 A1 (3)
Total for Question 6: 9 marks		



Question 7

8 marks

Part	Scheme	Marks
(a)	Divides $x^4 + 2x^3 + 0x^2 + 7x + 7$ by $x^2 + 1$ Quotient $x^2 + 2x - 1$ Remainder $5x + 8$ $B = 2, C = -1, D = 5, E = 8$ $g(x) \equiv x^2 + 2x - 1 + \frac{5x+8}{x^2+1}$ Comparing coefficients in $x^4 + 2x^3 + 7x + 7 \equiv (x^2 + Bx + C)(x^2 + 1) + Dx + E$ is equally valid. A zero x^2 term in the numerator must be allowed for in long division.	M1 A1 A1 A1 A1 (5)
(b)	$x^2 + 1 > 0$ for all x, so the inequality sign is unchanged: $5x + 8 > x^2 + 1$ $x^2 - 5x - 7 < 0$, critical values $\frac{5 \pm \sqrt{53}}{2}$ $\frac{5 - \sqrt{53}}{2} < x < \frac{5 + \sqrt{53}}{2}$	M1 M1 A1 (3)
Total for Question 7: 8 marks		

Question 8

8 marks

Part	Scheme	Marks
(a)	Multiplies by the reciprocal of the second fraction Factorises: $(x-2)(x+2)$, $(x+1)(x+2)$, $(x-2)(x-3)$, $(x-3)(x+1)$ All four correct $\frac{(x-2)(x+2)}{(x+1)(x+2)} \times \frac{(x-3)(x+1)}{(x-2)(x-3)} = 1$ *	M1 M1 A1 A1* (4)
(b)	Denominators zero: $x = -1, -2$ and $x = 3$; the divisor is zero at $x = 2$ and $x = 3$ $x = -2, -1, 2, 3$	M1 A1 (2)
(c)	$1 = x^2 - 3 \Rightarrow x = \pm 2$ Both values are excluded (part (b)), so there are no solutions *	M1 A1* (2)
Total for Question 8: 8 marks		



Question 9

9 marks

Part	Scheme	Marks
(a)	$\frac{(r+1) - r}{r(r+1)}$ $= \frac{1}{r(r+1)} *$	M1 A1* (2)
(b)	Writes the sum as $(1 - \frac{1}{2}) + (\frac{1}{2} - \frac{1}{3}) + \dots + (\frac{1}{n} - \frac{1}{n+1})$ At least the first two and the last term shown Middle terms cancel, leaving $1 - \frac{1}{n+1}$ $= \frac{n+1-1}{n+1} = \frac{n}{n+1} *$	M1 A1 M1 A1* (4)
(c)	$\frac{n}{n+1} > 0.99 \Rightarrow n > 0.99n + 0.99$ $0.01n > 0.99, \text{ so } n > 99$ $n = 100$ <i>Multiplying by $n+1$ is valid because $n+1 > 0$.</i>	M1 A1 A1 (3)
Total for Question 9: 9 marks		



Question 10

10 marks

Part	Scheme	Marks
(a)	$2x^2 + kx - 3 \equiv (2x + 1)(x + 2) + C$ $(2x + 1)(x + 2) = 2x^2 + 5x + 2$ $k = 5$ $C = -5$	M1 A1 A1 A1 (4)
(b)	$2x + 1 - \frac{5}{x+2} = 2x - 1 \Rightarrow \frac{5}{x+2} = 2$ $x = \frac{1}{2}$	M1 A1 (2)
(c)	$f(x) - (2x + 1) = -\frac{5}{x+2} < 0$ because $x + 2 > 0$ for $x > -2$	B1 (1)
(d)	$1 - \frac{5}{x+2} > 0$ Multiplies by $(x + 2)^2$ (positive): $(x + 2)(x - 3) > 0$, critical values -2 and 3 $x < -2$ or $x > 3$ <i>Multiplying by $(x + 2)$ alone loses the region $x < -2$, where $x + 2$ is negative.</i>	M1 M1 A1 (3)
Total for Question 10: 10 marks		

