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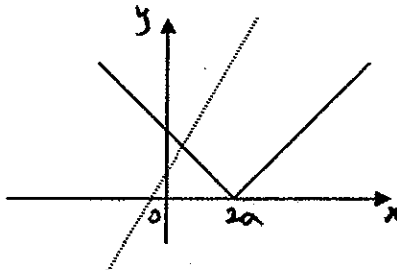
January 2005

Advanced Subsidiary/Advanced Level

General Certificate of Education

Subject: Further Pure Mathematics

Paper: P4/FP1

Question Number	Scheme	Marks
1	<p>(a)</p>  <p>Shape, vertex on x-axis</p> <p>At least 2a seen on positive x-axis</p> <p>(b) Attempting to solve $-(x - 2a) = 2x + a$ anywhere Completely correct method [e.g. solving $-(x - 2a) > 2x + a$; if finding two "solutions" needs to be evidence for giving "correct" result]</p> <p>$x < \frac{1}{3}a$</p>	<p>B1</p> <p>B1 (2)</p> <p>M1</p> <p>dep M1</p> <p>A1 (3) [5]</p>
2	<p>(a) Second root = $3 - i$</p> <p>Finding product of two roots (= 10), or quadratic factor $(x^2 - 6x + 10)$</p> <p>Complete method for third root or linear factor</p> <p>Third root = $\frac{1}{2}$</p> <p>(b) Using candidate's three roots to find cubic with real coefficients (= $2x^3 - 13x^2 + 26x - 10$)]</p> <p>Equating coefficients</p> <p>$a = -13, \quad b = 26$</p>	<p>B1</p> <p>M1</p> <p>M1</p> <p>A1 (4)</p> <p>M1</p> <p>M1</p> <p>A1 (3) [7]</p>

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3	<p>I.F. = $e^{\int 2 \cot 2x dx}$; = $\sin 2x$</p> <p>Multiplying throughout by IF.</p> <p>$y \times (\text{IF}) = \text{integral of candidate's RHS}$</p> $= \int 2 \sin^2 x \cos x dx \quad \text{or} \quad \int -\left(\frac{\cos 3x - \cos x}{2}\right) dx$ <p>[This M gained when in position to complete integration, dep on M *]</p> $= \frac{2}{3} \sin^3 x (+ C) \quad \text{or} \quad -\frac{1}{6} \sin 3x + \frac{1}{2} \sin x + c$ $y = \frac{2 \sin^3 x}{3 \sin 2x} + \frac{C}{\sin 2x} \quad \text{or} \quad -\frac{\sin 3x}{6 \sin 2x} + \frac{\sin x}{2 \sin 2x} + \frac{c}{\sin 2x} \quad \text{or equiv.}$	<p>M1A1</p> <p>M1 *</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>A1✓ [7]</p>
4	<p>(a) Correct method for $f(x)$; $x \cos x + \sin x + 2$</p> <p>$f(1) = -0.1585$, $f(1) = 3.382$ or better seen</p> <p>Using N-R correctly: $u_1 = 1 - \frac{"-0.1585"}{"3.382"} ; = 1.05$ (3 s.f)</p> <p>[Notes: Answer 1.047, 1.05 implies second A mark]</p> <p>(b) Two tangents drawn, one at $\{5, f(5)\}$, the other at $\{x_2, f(x_2)\}$</p> <p>x_2, x_3 marked in appropriate positions</p>	<p>M1A1</p> <p>A1</p> <p>M1A1 (5)</p> <p>M1</p> <p>A1 (2) [7]</p>

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5	<p>(a) $\frac{1}{r(r+2)} \equiv \frac{A}{r} + \frac{B}{r+2} \equiv \frac{A(r+2) + Br}{r(r+2)}$ and attempt to find A and B</p> <p style="margin-left: 100px;">$\equiv \frac{1}{2r} - \frac{1}{2(r+2)}$</p>	<p>M1</p> <p>A1 (2)</p>
	<p>(b) $\sum \frac{4}{r(r+2)} \equiv 2 \left[\frac{1}{r} - \frac{1}{r+2} \right]$</p> <p>$\sum_1^n \left[\frac{1}{r} - \frac{1}{r+2} \right] = \left\{ 1 - \frac{1}{3} \right\} + \left\{ \frac{1}{2} - \frac{1}{4} \right\} + \left\{ \frac{1}{3} - \frac{1}{5} \right\} + \dots$</p> <p style="margin-left: 100px;">$+ \left\{ \frac{1}{n-1} - \frac{1}{n+1} \right\} + \left\{ \frac{1}{n} - \frac{1}{n+2} \right\}$</p> <p>[If A and B incorrect, allow A1 ✓ here only, providing still differences]</p> <p style="margin-left: 100px;">$= \frac{3}{2} - \frac{1}{n+1} - \frac{1}{n+2}$</p>	<p>M1A1</p> <p>A1</p>
	<p>Forming single fraction: $\frac{3(n+1)(n+2) - 2(n+2) - 2(n+1)}{2(n+1)(n+2)}$</p>	<p>M1</p>
	<p>Deriving given answer $\frac{n(3n+5)}{(n+1)(n+2)}$, cso</p>	<p>A1 (5)</p>
	<p>(c) Using $S(100) - S(49) = \frac{100 \times 305}{101 \times 102} - \frac{49 \times 152}{50 \times 51}$</p> <p style="margin-left: 40px;">[= 2.96059... - 2.92078...]</p> <p style="margin-left: 40px;">= 0.0398 (4 d.p.)</p>	<p>M1A1</p> <p>A1 (3) [10]</p>
	<p>[Allow $S(100) - S(50)$, ($\Rightarrow 0.0383$) for M1]</p>	

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6	<p>(a) $\frac{dy}{dx} = x \frac{dv}{dx} + v, \quad \frac{d^2y}{dx^2} = x \frac{d^2v}{dx^2} + 2 \frac{dv}{dx}$</p> <p>[M1 for diff. product, A1 both correct]</p> <p>$\therefore x^2 \left(x \frac{d^2v}{dx^2} + 2 \frac{dv}{dx} \right) - 2x \left(x \frac{dv}{dx} + v \right) + (2 + 9x^2)vx = x^5$</p> <p>$x^3 \frac{d^2v}{dx^2} + 2x^2 \frac{dv}{dx} - 2x^2 \frac{dv}{dx} - 2vx + 2vx + 9vx^3 = x^5$</p> <p>$[x^3 \frac{d^2v}{dx^2} + 9vx^3 = x^5]$</p> <p>Given result: $\frac{d^2v}{dx^2} + 9v = x^2$ cso</p> <p>(b) CF: $v = A \sin 3x + B \cos 3x$ (may just write it down)</p> <p>Appropriate form for P1: $v = \lambda x^2 + \mu$ (or $ax^2 + bx + c$)</p> <p>Complete method to find λ and μ</p> <p>$v = A \sin 3x + B \cos 3x + \frac{1}{9}x^2 - \frac{2}{81}$</p> <p>[f.t. only on wrong CF]</p> <p>(c) $\therefore y = Ax \sin 3x + Bx \cos 3x + \frac{1}{9}x^3 - \frac{2}{81}x$</p> <p>[f.t. for $y = x$ (candidate's CF + PI), providing two arbitrary constants]</p>	<p>M1A1</p> <p>M1</p> <p>A1</p> <p>A1 (5)</p> <p>M1A1</p> <p>M1</p> <p>M1</p> <p>M1A1√ (6)</p> <p>B1√ (1) [12]</p>

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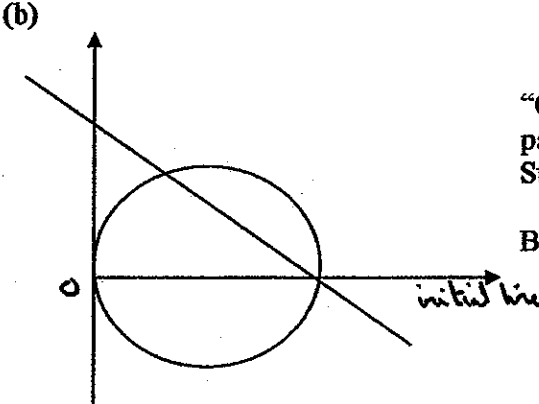
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7	<p>(a) For C: Using polar/ cartesian relationships to form Cartesian equation so $x^2 + y^2 = 6x$ [Equation in any form: e.g. $(x - 3)^2 + y^2 = 9$ from sketch. or $\sqrt{x^2 + y^2} = \frac{6x}{\sqrt{x^2 + y^2}}$]</p> <p>For D: $r \cos\left(\frac{\pi}{3} - \theta\right) = 3$ and attempt to expand $\frac{x}{2} + \frac{\sqrt{3}y}{2} = 3 \quad (\text{any form})$</p> <p>(b)</p>  <p>“Circle”, symmetric in initial line passing through pole Straight line Both passing through (6, 0)</p> <p>(c) Polars: Meet where $6 \cos \theta \cos\left(\frac{\pi}{3} - \theta\right) = 3$ $\sqrt{3} \sin \theta \cos \theta = \sin^2 \theta$ $\sin \theta = 0$ or $\tan \theta = \sqrt{3} \quad \left[\theta = 0 \text{ or } \frac{\pi}{3}\right]$ Points are $(6, 0)$ and $\left(3, \frac{\pi}{3}\right)$</p>	<p>M1 A1 M1 M1A1 (5) B1 B1 B1 (3) M1 M1 M1 B1,A1 (5) [13]</p>

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7	<p>Alternatives (only more common):</p> <p>(a) Equation of D:</p> <p>Finding two points on line</p> <p>Using correctly in Cartesian equation for straight line</p> <p>Correct Cartesian equation</p> <hr/> <p>(c)</p> <p>Cartesian: Eliminate x or y to form quadratic in one variable</p> $[2x^2 - 15x + 18 = 0, \quad 4y^2 - 6\sqrt{3}y = 0]$ <p>Solve to find values of x or y</p> <p>Substitute to find values of other variable</p> $\left[x = \frac{3}{2} \text{ or } 6; \quad y = 0 \text{ or } \frac{3\sqrt{3}}{2} \right]$ <p>Points must be $(6, 0)$ and $(3, \frac{\pi}{3})$</p>	<p>M1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>M1</p> <p>B1A1</p>

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8	<p>(a) $\left \frac{z}{w} \right = \frac{ z }{ w } = \frac{4}{2} = 2$</p> <p>[M1 for correct modulus, M1 division of moduli]</p>	M1M1A1 (3)
	<p>(b) $\arg\left(\frac{z}{w}\right) = \arg z - \arg w$</p> <p style="text-align: center;">$= \frac{3\pi}{4} - \left(-\frac{\pi}{3}\right) = \left(\frac{13\pi}{12}\right); \quad \frac{11\pi}{12}$</p> <p>[Second M1 for one correct arg]</p>	M1 M1A1 (3)
	<p>Working with $\left(\frac{z}{w}\right)$:</p>	
	<p>(a) $\left(\frac{z}{w}\right) = \frac{2\sqrt{2}(-1+i)}{1-i\sqrt{3}} = \frac{2\sqrt{2}(-1+i)(1+i\sqrt{3})}{4}$</p> <p style="text-align: center;">$\left[= \frac{\sqrt{2}\{-(1+\sqrt{3})-i(\sqrt{3}-1)\}}{2} \right]$</p> <p>Correct method for finding modulus, = 2</p>	M1 M1A1 (3)
	<p>(b) Finding $\tan^{-1} \frac{(\sqrt{3}-1)}{(\sqrt{3}+1)}$</p> <p>Complete method for $\arg\left(\frac{z}{w}\right)$</p> <p style="text-align: center;">$= -\frac{11\pi}{12}$</p>	M1 M1 A1 (3)

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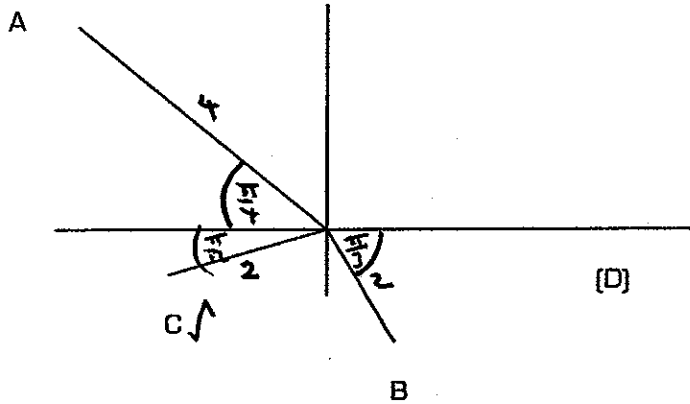
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8	<p>(c)</p>  <p>(d)</p> $\angle DOB = \frac{\pi}{3} \text{ or } 60^\circ$ <p>Correct method for $\angle AOC$</p> $\angle AOC = \frac{\pi}{4} + \frac{\pi}{12} = \frac{\pi}{3} \quad (\text{cso})$ <p>(e)</p> $\text{Area } \Delta AOC = \frac{1}{2} \times 4 \times 2 \times \sin \frac{\pi}{3} = 2\sqrt{3} \quad (3.46 \text{ or better})$	<p>(3)</p> <p>For A B1 For B B1 For C B1√</p> <p>B1 M1 A1 (3)</p> <p>M1A1 (2)</p> <p>[14]</p>