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ADDITIONAL MATHEMATICS

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MARK SCHEME
Maximum Mark: 80

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This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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MARK SCHEME NOTES

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

- M Method marks, awarded for a valid method applied to the problem.
- Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. For accuracy Α marks to be given, the associated Method mark must be earned or implied.
- В Mark for a correct result or statement independent of Method marks.

When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. The notation 'dep' is used to indicate that a particular M or B mark is dependent on an earlier mark in the scheme.

Abbreviations

answers which round to awrt correct answer only cao

dep dependent

follow through after error FT ignore subsequent working isw not from wrong working nfww

or equivalent oe

rounded or truncated rot

Special Case SC seen or implied soi

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Question	Answer	Marks	Guidance
1(i)	$A' \cap B$	B1	
1(ii)	$A \cap B \cap C$	B1	
1(iii)	$A \cup B$	B1	
2(i)	$p\left(\frac{1}{2}\right) = \frac{a}{8} + \frac{b}{4} - \frac{13}{2} + 4$	M1	attempt at $p\left(\frac{1}{2}\right)$
	$p'(x) = 3ax^{2} + 2bx - 13$ $p'\left(\frac{1}{2}\right) = \frac{3a}{4} + b - 13$	M1	attempt at $p'\left(\frac{1}{2}\right)$
	leading to $a + 2b = 20$ and $3a + 4b - 52 = 0$	A1	at least one correct equation
	solution of simultaneous equations	DM1	
	a = 12, b = 4	A1	for both
2(ii)	p(-1) = -12 + 4 + 13 + 4	M1	
	9	A1	FT on <i>their</i> integer values of a and b
3(a)	$Tg^{\frac{1}{2}} = 2\pi l^{\frac{1}{2}}$ $T^2g = 4\pi^2 l$	B1	multiplication/dealing with power of $\frac{1}{2}$ or squaring
	$l = \frac{T^2 g}{4\pi^2} \text{ or } \left(\frac{Tg^{\frac{1}{2}}}{2\pi}\right)^2$	B1	for either
3(b)	$y^2 - 4y + 3 = 0$ leading to $y = 1$, $y = 3$	M1	reduction to quadratic equation and attempt to solve
	$x^{\frac{1}{3}} = 1, x^{\frac{1}{3}} = 3$	DM1	attempt to solve $x^{\frac{1}{3}} = k$ (positive k)
	x = 1, x = 27	A2	A1 for each

Question	Answer	Marks	Guidance
4(i)	$\frac{1}{2}$	B1	
4(ii)	$\lg y = mx^2 + c$ $\lg y = \frac{1}{2}x^2 + 1$	B2	-1 for each error
4(iii)	$y = 10^{\left(\frac{x^2}{2} + 1\right)}$	B1	dealing with lg on their (ii)
	$y = 10\left(10^{\frac{x^2}{2}}\right)$	B2	B1 for each, dependent on first B1
5(i)	(0, 20)	B1	
5(ii)	31.7	B1	
5(iii)	$2e^{2x} - 8e^{-2x} (+c)$	B2	B1 for each correct term
5(iv)	Area of trapezium = $\frac{1}{2}$ (20 + 31.7) = 25.86 or 25.85	B1	
	$\left[2e^{2x} - 8e^{-2x}\right]_0^1 = \left(2e^2 - 8e^{-2}\right) - \left(-6\right)$	M1	substitution of both limits, must have come from integration of the form $ae^{2x} + be^{-2x}$.
	19.7	A1	
	Required area = 6.15, 6.16, 6.17	A1	
6(a)(i)	f ≥ 3	B1	must be using a correct notation
6(a)(ii)	$(4x-1)^2 + 3 = 4$	M1	correct order
	solution of resulting quadratic equation	DM1	
	$x = 0, \ x = \frac{1}{2}$	A1	both required

Question	Answer	Marks	Guidance
6(b)(i)	xy - 4y = 2x + 1	M1	'multiplying out'
	x(y-2) = 4y+1	M1	collecting together like terms
	$x = \frac{4y+1}{y-2}$		
	$h^{-1}(x) = \frac{4x+1}{x-2}$	A1	correct answer with correct notation
	Range $h^{-1} \neq 4$	B1	must be using a correct notation
6(b)(ii)	$h^{2}(x) = h\left(\frac{2x+1}{x-4}\right)$	M1	dealing with h ² correctly
	$=\frac{2\left(\frac{2x+1}{x-4}\right)+1}{\left(\frac{2x+1}{x-4}\right)-4}$		
	dealing with fractions within fractions	M1	
	$=\frac{5x-2}{17-2x} \text{oe}$	A1	
7(i)	$\ln(2x+1) - \ln(2x-1)$	B1	
7(ii)	attempt to differentiate	M1	
	$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{2}{2x+1} - \frac{2}{2x-1} + 4$	A1	all correct
	attempt to obtain in required form	DM1	
	$=\frac{16x^2 - 8}{4x^2 - 1}$	A1	A1 all correct
7(iii)	When $\frac{dy}{dx} = 0$, $16x^2 - 8 = 0$	M1	setting $\frac{dy}{dx} = 0$ and attempt to solve
	$x = \frac{1}{\sqrt{2}}$ only	A1	

Question	Answer	Marks	Guidance
7(iv)	$\frac{d^2 y}{dx^2} = \frac{32x(4x^2 - 1) - 8x(16x^2 - 8)}{(4x^2 - 1)^2}$	M1	attempt at second derivative and conclusion or equivalent method
	When $x = \frac{1}{\sqrt{2}} \frac{d^2 y}{dx^2}$ is + ve, so minimum	A1	
8(a)(i)	${}^8C_6 \times {}^6C_4$	B1	either 8C_6 or 6C_4
	420	B1	
8(a)(ii)	$^{12}C_8 + ^{12}C_{10}$	B2	B1 for each
	= 561	B1	
	Alternate scheme: $1001 - (2 \times {}^{12}C_9)$	B1 B1	
	= 561	B1	
8(b)(i)	136 080	B1	
8(b)(ii)	No of ways ending with 0 - 15 120	B1	
	No of ways ending with 5 - 13 440	B1	
	Total 28 560	B1	
8(b)(iii)	Starting with 6 or 8 - 13 440	B1	
	Starting with 7 or 9 - 16 800	B1	
	Total = 30 240	B1	
9(i)	$\tan\left(\frac{PAQ}{2}\right) = 2.4$	M1	valid method
	PAQ = 2.352(01) PAQ = 2.35 correct to 3 sf	A1	must see greater than 3 sf then rounding
9(ii)	PBQ = 0.790 or 0.792	B1	
9(iii)	$(2.352\times10)+(0.790\times24)$	M1,A1	M1 for correct attempt at an arc length A1 for one correct arc length
	= awrt 42.5	A1	

Question	Answer	Marks	Guidance
9(iv)	$\left(\left(\frac{1}{2} \times 24^2 \times 0.790 \right) - \left(\frac{1}{2} \times 24^2 \times \sin 0.790 \right) \right)$	B1,B1	B1 for a correct sector area allow, unsimplified B1 for a correct area of a triangle, allow unsimplified
	$+ \left(\left(\frac{1}{2} \times 10^2 \times 2.352 \right) - \left(\frac{1}{2} \times 10^2 \times \sin 2.352 \right) \right)$	B1	correct plan, dependent on both previous B marks
	= 22.94 + 82.1	B1	
	= 105		
10(a)	$\frac{3}{4} = \sin^2 2x$	B1	dealing correctly with cosec
	$\sin 2x = \pm \frac{\sqrt{3}}{2}$ $2x = 60, 120, 240, 300$	M1	correct method of solution including dealing with 2x correctly, may be implied by one correct solution.
	x = 30, 60, 120, 150	A2	A1 for each correct pair
10(b)	$\tan\left(y - \frac{\pi}{4}\right) = \frac{1}{\sqrt{3}}$	M1	dealing with order of operations to obtain a first solution
	$y - \frac{\pi}{4} = \frac{\pi}{6}, \ \frac{7\pi}{6}$	M1	M1 for attempt to obtain a second solution
	$y = \frac{5\pi}{12}, \ \frac{17\pi}{12}$	A2	A1 for each

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