

Question	Answer	Marks	Guidance
1(a)	$243x^{10} - 45x^7 + \frac{10}{3}x^4$	3	B1 for $243x^{10}$ B1 for $-45x^7$ B1 for $\frac{10}{3}x^4$
1(b)	$\left(1 + \frac{1}{x^3}\right)^2 = 1 + \frac{2}{x^3} + \frac{1}{x^6}$ oe	B1	
	Coefficient of term in x^4 $= 243 - (2 \times 45) + \frac{10}{3}$	M1	For <i>their</i> $243 + 2 \times \text{their}(-45) +$ <i>their</i> $\frac{10}{3}$ Must have 3 terms
	$\frac{469}{3}$ oe	A1	
2(a)	$\cos BOA = \frac{7}{32}$ or $\sin \frac{BOA}{2} = \frac{5}{8}$	M1	
	$BOA = 1.350(263\dots)$ $BOA = 1.35$ (correct to 2 dp)	A1	Must see detail of extra decimal places to justify 2 dp answer
2(b)	$8\theta = 18$	M1	
	$\theta = 2.25$	A1	
2(c)	$\angle AOC = 2\pi - 2.25 - 1.35\dots$ (2.683)	M1	For use of $2\pi - \text{their}(b) - 1.35\dots$
	Area = $\frac{1}{2}64(\text{their } 2.683\dots)$	M1	For use of sector area formula
	85.9 or 85.8	A1	Allow awrt 85.9
	Alternative Area = $64\pi - \left(\frac{1}{2} \times 64 \times 1.35\dots\right) - \left(\frac{1}{2} \times 64 \times 2.683\right)$	(2)	M1 for a correct plan M1 for one correct use of sector area formula
	85.9 or 85.8	(A1)	Allow awrt 85.9 or 85.8

Question	Answer	Marks	Guidance
3(a)	$(2e^{3x} - 5)(e^{3x} + 1) = 0$	M1	For attempt to solve a 3-term quadratic equation in e^{3x} , or using an appropriate substitution. May also be implied by correct use of quadratic formula
	$x = \frac{1}{3} \ln \frac{5}{2}$	2	Dep M1 for a correct attempt to obtain $x = \dots$ A1 cao with negative root discounted.
3(b)	$e^{-x-7-7y} = e^{-2}$	M1	For correct attempt to deal with powers of e
	$x + 7y = -5$	A1	
	$x^2 + 5x - 126 = 0$ or $7y^2 + 5y - 18 = 0$	M1	Dep for attempt to obtain a 3-term quadratic equation equated to zero in either x or y
	$x = -14, x = 9$	A1	For both
	$y = \frac{9}{7}, y = -2$	A1	For both
4(a)	Intercept = -2 soi	B1	
	$e^{4y} = \frac{2}{5}x - 2$	M1	For attempt at straight line equation with <i>their</i> intercept
	$y = \frac{1}{4} \ln \left(\frac{2}{5}x - 2 \right)$ oe	A1	
4(b)	$y = \frac{1}{4} \ln 16$	M1	Dep on M1 in part (a)
	$y = \ln 2$	A1	
4(c)	$x > 5$	1	
5(a)	Acceleration = $18 \cos 3t$	2	B1 for $k \cos 3t$, $k \neq 2$, $k > 0$
	$\cos 3t = -\frac{1}{2}$ oe	M1	For attempt to solve <i>their</i> $\cos 3t = -\frac{1}{2}$ to obtain a value for t
	$t = \frac{2\pi}{9}$ or 0.698	A1	

Question	Answer	Marks	Guidance												
5(b)	$-2 \cos 3t \ (+c)$	2	B1 for $k \cos 3t$, $k \neq 18$, $k < 0$												
	Displacement = $2 - 2 \cos 3t$	M1	For attempt to find value of c												
	2.92	A1													
	Alternative $-2 \cos 3t$	(2)	B1 for $k \cos 3t$, $k \neq 18$, $k < 0$												
	$[-2 \cos 3t]_0^{5.6}$ $= (-2 \cos 16.8) - (-2)$	(M1)	For correct application of limits using <i>their</i> $k \cos 3t$, $k \neq 18$, $k < 0$												
	2.92	(A1)													
6(a)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Expression</th> <th>Function notation</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>g''</td> </tr> <tr> <td>$4x$</td> <td>f'</td> </tr> <tr> <td>$8x^2 + 8x + 2$</td> <td>fg</td> </tr> <tr> <td>$4x + 3$</td> <td>g^2</td> </tr> <tr> <td>$\frac{x-1}{2}$</td> <td>g^{-1}</td> </tr> </tbody> </table>	Expression	Function notation	0	g''	$4x$	f'	$8x^2 + 8x + 2$	fg	$4x + 3$	g^2	$\frac{x-1}{2}$	g^{-1}	5	B1 for each one correct
Expression	Function notation														
0	g''														
$4x$	f'														
$8x^2 + 8x + 2$	fg														
$4x + 3$	g^2														
$\frac{x-1}{2}$	g^{-1}														
6(b)(i)	$a = 1$	B1													
6(b)(ii)	$h(x) \geq 3$	B1													
6(b)(iii)	$x = (y-1)^2 + 3$ $y = 1 + \sqrt{x-3}$	M1	For a correct attempt to find the inverse, allow one sign error												
	$h^{-1}(x) = 1 + \sqrt{x-3}$	A1	Must be using correct notation												
	$x \geq 3$	B1	Must be using correct notation												

Question	Answer	Marks	Guidance
7(a)	$\frac{dy}{dx} = \frac{\left((x+5) \times \frac{3}{2} \times 2(2x+1)^{\frac{1}{2}} - (2x+1)^{\frac{3}{2}} \right)}{(x+5)^2}$	3	B1 for $\frac{3}{2} \times 2(2x+1)^{\frac{1}{2}}$ oe M1 for attempt to differentiate a quotient or product A1 for all terms other than $\frac{3}{2} \times 2(2x+1)^{\frac{1}{2}}$ correct
	$\frac{(2x+1)^{\frac{1}{2}}}{(x+5)^2} (x+14)$	A1	
7(b)	When $\frac{dy}{dx} = 0$, $x = -14$ and $x = -0.5$ but $x \geq 0$ so no stationary point	B1	FT on <i>their</i> $(x+14)$
7(c)	$\frac{5\sqrt{3}p}{12}$, $\frac{15\sqrt{3}p}{36}$ or $0.722p$	2	M1 for calculation of $\frac{dy}{dx}$ when $x = 1$ and multiplication by p
7(d)	$\frac{25\sqrt{3}}{24}$ or 1.80 oe	2	M1 for multiplication of <i>their</i> $\frac{dy}{dx}$ calculated in (c) by 2.5, must be numeric
8(a)(i)	17640	B1	
8(a)(ii)	Ends in a 5: 2160 or ${}^6P_1 \times {}^6P_4$	B1	
	Ends in a 0: 2520 or ${}^7P_1 \times {}^6P_4$	B1	
	4680	B1	
8(a)(iii)	Starts with 85 : 360 Starts with 86 : 360 Starts with 87 : 360 Starts with 89: 360 oe 1440 or $4 \times {}^6P_4$	B1	
	Starts with 9 : 2520 or 7P_5	B1	
	3960	B1	

Question	Answer	Marks	Guidance
8(b)	With brothers : 126 or 9C_5	B1	
	Without brothers : 9 or 9C_8	B1	
	135	B1	
9(a)	$\sin^2\left(2\phi - \frac{\pi}{3}\right) = \frac{3}{4}$ soi	B1	
	$\phi = \frac{\pi}{3}, \frac{\pi}{2}, \frac{5\pi}{6}$	3	M1 for a correct method of solution, may be implied by one correct solution. A1 for a second correct solution A1 for a third correct solution and no extra solutions within the range
9(b)	$\cot^2 \theta = \frac{1}{y+1}$	B1	
	Attempt to use $\cot^2 \theta + 1 = \operatorname{cosec}^2 \theta$	M1	For attempt to eliminate θ
	$y = \frac{1}{2x-2} - 1$ oe	2	Dep M1 for attempt to rearrange to obtain the required form
	Alternative $\frac{1}{\sin^2 \theta} = 2x - 1$ and $y + 1 = \frac{\sin^2 \theta}{\cos^2 \theta}$	(B1)	
	$y + 1 = \frac{1}{1 - \frac{1}{2x-1}}$ oe	(M1)	For attempt to eliminate θ
	$y = \frac{1}{2x-2} - 1$ oe	(2)	Dep M1 for attempt to rearrange to obtain the required form
10(a)	$\frac{6(x+1)^2 + 4(2+3x) - 2(2+3x)(x+1)}{(2+3x)(x+1)^2}$	M1	For dealing with the fractions, allow an extra $(x+1)$ in each of the terms in the numerator and in the denominator Allow one sign error
	$\frac{(14x+10)}{(2x+3)(x+1)^2}$	A1	AG - Must have sufficient evidence of expansion and simplification to obtain the given answer

Question	Answer	Marks	Guidance
10(b)	$\left[2 \ln(2x+3) - \frac{4}{(x+1)} - 2 \ln(x+1) \right]$	3	B1 for each term, must have the correct signs with each term Must be using part (a)
	$\left(2 \ln 8 - \frac{4}{3} - 2 \ln 3 \right) - (2 \ln 2 - 4)$	M1	Dep on at least one log term in <i>their</i> integral, for use of limits
	$\frac{8}{3} + \ln \frac{16}{9}$	2	A1 for $\ln \frac{16}{9}$ A1 for $\frac{8}{3}$