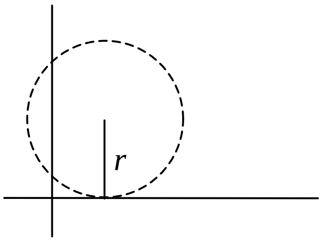
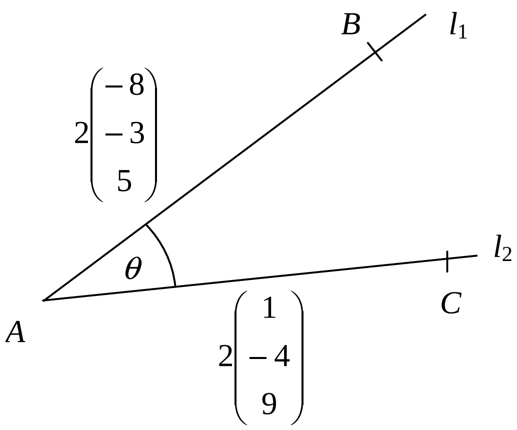
Question Number	Scheme	Marks
1.	$\frac{dy}{dx} = \frac{1}{\operatorname{cosec} x + \cot x}(-\operatorname{cosec} x \cot x + -\operatorname{cosec}^2 x)$ Full attempt at chain rule	M1
	$= -\operatorname{cosec} x \frac{(\cot x + \operatorname{cosec} x)}{\operatorname{cosec} x + \cot x}$ Factorise cosec x	M1
	$= -\operatorname{cosec} x$ (*)	A1 cso (3)
		(3 marks)
2. (*a*)	3	B1 (1)
(*b*)	$f(2) = 24 \Rightarrow 24 = (4 + p) \times 7 + 3$ Attempt f(±2)	M1
	$\Rightarrow p = -1$ (*)	A1 cso (2)
(*c*)	$f(x) = (x^2 - 1)(2x + 3) + 3$ Attempt to multiply out	M1
	$= 2x^3 + 3x^2 - 2x - 3 + 3$	
	$= x(2x^2 + 3x - 2)$ Factor of x	M1
	$= x(2x - 1)(x + 2)$ Attempt to factorise 3 term quadratic	M1, A1 (4)
		(7 marks)
3. (*a*)	 Eqn: $(x - 5)^2 + (y - 13)^2 = r^2$	M1
	$r = 13$ $(x - 5)^2 + (y - 13)^2 = 13^2$	A1 (2)
(*b*)	Differentiate: $2(x - 5) + 2(y - 13)\frac{dy}{dx} = 0$ Attempt to diff.	M1
	At (10, 1) $(2 \times 5) + 2 \times -12\frac{dy}{dx} = 0$ Use of (10, 1)	M1
	$\frac{dy}{dx} = \frac{10}{24}$ or $\frac{5}{12}$	A1
	Eqn. of tangent $y - 1 = \frac{5}{12}(x - 10)$ f.t. on their m	M1
	$5x - 12y - 38 = 0$	A1 (5)
		(7 marks)

Question Number	Scheme	Marks
4.	$u = 1 + \sin x \Rightarrow \frac{du}{dx} = \cos x$ or $du = \cos x\, dx$ or $dx = \frac{du}{\cos x}$	M1
	$I = \int (u-1)u^5 du$ Full sub. to I in terms of u, correct	M1, A1
	$= \int (u^6 - u^5)\, du$ Correct split	M1
	$= \frac{u^7}{7} - \frac{u^6}{6}\ (+ c)$ M1 for $u^n \to u^{n+1}$	M1, A1
	$= \frac{u^6}{42}(6u - 7)\ (+ c)$ Attempt to factorise	M1
	$= \frac{(1+\sin x)^6}{42}(6\sin x + 6 - 7)\ (+ c) = \frac{(1+\sin x)^6}{42}(6\sin x - 1)\ (+ c)$ (*)	A1 cso
		(8 marks)
Alt	Integration by parts	M1
	$I = (u-1)\frac{u^6}{6} - \frac{1}{6}\int u^6\, du$ Attempt first stage	M1
	$= (u-1)\frac{u^6}{6} - \frac{u^7}{42}$ Full integration	A1
	$= \frac{u^7}{6} - \frac{u^6}{6} - \frac{u^7}{42}$ or $\frac{6u^7 - 7u^6}{42}$	rest as scheme
5. (*a*)	$3 + 5x \equiv A(1 - x) + B(1 + 3x)$ Method for A or B	M1
	$(x = 1) \Rightarrow 8 = 4B$ $B = 2$	A1
	$(x = -\frac{1}{3}) \Rightarrow \frac{4}{3} = \frac{4}{3}A$ $A = 1$	A1 (3)
(*b*)	$2(1 - x)^{-1} = 2[1 + x + x^2 + \ldots]$ Use of binomial with $n = -1$ scores M1(×2)	M1 [A1]
	$(1 + 3x)^{-1} = [1 - 3x + \frac{(-1)(-2)}{2!}(3x)^2 + \ldots]$	M1 [A1]
	$\therefore \frac{3+5x}{(1-x)(1+3x)} = 2 + 2x + 2x^2 + 1 - 3x + 9x^2 = 3 - x + 11x^2$	A1 (5)
(*c*)	$(1 + 3x)^{-1}$ requires $\lvert x \rvert < \frac{1}{3}$, so expansion is *not* valid.	M1, A1 (2)
		(10 marks)

Question Number	Scheme		Marks
6. (*a*)	$4 = 2\sec t \;\Rightarrow\; \cos t = \frac{1}{2}, \Rightarrow t = \frac{\pi}{3}$		M1, A1
	$\therefore\; a = 3\times\frac{\pi}{3}\times\sin\frac{\pi}{3} = \frac{\pi\sqrt{3}}{2}$		B1 (3)
(*b*)	$A = \int_0^a y\,dx \;=\; \int y\frac{dx}{dt}\,dt$	Change of variable	M1
	$= \int 2\sec t\times[3\sin t + 3t\cos t]\,dt$	Attempt $\frac{dx}{dt}$	M1
	$= \int_0^{\frac{\pi}{3}}(6\tan t, + 6t)\,dt \quad (*)$	Final A1 requires limit stated	A1, A1cso (4)
(*c*)	$A = [6\ln\sec t + 3t^2]_0^{\frac{\pi}{3}}$	Some integration (M1) both correct (A1) ignore lim.	M1, A1
	$= (6\ln 2 + 3\times\frac{\pi^2}{9}) - (0)$	Use of $\frac{\pi}{3}$	M1
	$= 6\ln 2 + \frac{\pi^2}{3}$		A1 (4)
			(11 marks)
7. (*a*)	$A = \pi r^2,\; \frac{dr}{dt} = 4\lambda e^{-\lambda t}$		B1, B1
	$\frac{dA}{dt} = 2\pi r\frac{dr}{dt},\Rightarrow\; \frac{dA}{dt} = 2\pi\times 4(1 - e^{-\lambda t})\times 4\lambda e^{-\lambda t}$		M1, M1
	$\frac{dA}{dt} = 32\pi\lambda(e^{-\lambda t} - e^{-2\lambda t})$		A1cso (5)
(*b*)	$\int A^{-\frac{3}{2}}dA = \int t^{-2}dt$	Separation	M1
	$\frac{A^{-\frac{1}{2}}}{-\frac{1}{2}} = \frac{t^{-1}}{-1}\;(+c)$		M1, A1
	$-2 = -1 + c$	Use of (1, 1)	M1
	$c = -1$		A1
	So $2A^{-\frac{1}{2}} = \frac{1}{t} + 1 \quad\Rightarrow\quad \sqrt{A} = \frac{2t}{1+t}$	Attempt $\sqrt{A} =$ or $A =$	M1
	i.e. $A = \frac{4t^2}{(1+t)^2}$		A1 (7)
(*c*)	Because $\frac{t^2}{(1+t)^2} < 1$ or $t^2 < (1+t)^2 \quad (\Rightarrow A < 4)$		B1 (1)
			(13 marks)

Question Number	Scheme		Marks	
8. (*a*)	$9 - 8t = -16 + s$	Attempt a correct equation	M1	
	$4 + 5t = 10 + 9s$	Both correct	A1	
	Sub. $s = 25 - 8t \Rightarrow 5t = 6 + 225 - 72t$	Solving either	M1	
	$77t = 231$ or $t = 3,\ s = 1$		A1	
	Sub. into 'j' $2 - 3t = \alpha - 4s$	Use of 3rd equation	M1	
	$\Rightarrow \alpha = -3$		A1	(6)
(*b*)	$\overrightarrow{OA} = \begin{pmatrix} -15 \\ -7 \\ 19 \end{pmatrix}$		B1	(1)
(*c*)	$\begin{pmatrix} -8 \\ -3 \\ 5 \end{pmatrix} . \begin{pmatrix} 1 \\ -4 \\ 9 \end{pmatrix} = -8 + 12 + 45\ (= 49)$	Attempt scalar product	M1	
	$\cos\theta = \frac{49}{\sqrt{8^2 + 3^2 + 5^2}\sqrt{1^2 + 4^2 + 9^2}} = \frac{49}{\sqrt{98}\sqrt{98}} = \frac{1}{2}$	Use of $\frac{\mathbf{a.b}}{\lvert\mathbf{a}\rvert\lvert\mathbf{b}\rvert}$, $\lvert\mathbf{a}\rvert$ or $\lvert\mathbf{b}\rvert$	M1, M1	
	$\cos\theta = \frac{1}{2}$		A1	
	$\theta = 60°$ (*)		A1 cso	(5)
		$14\text{m} = 2\times7\sqrt{2} = 2\sqrt{98}$	B1	
	$\overrightarrow{OB} = \overrightarrow{OA} \pm 2\begin{pmatrix} -8 \\ -3 \\ 5 \end{pmatrix} = \begin{pmatrix} -31 \\ -13 \\ 29 \end{pmatrix}$ or $\begin{pmatrix} 1 \\ -1 \\ 9 \end{pmatrix}$	M1: $\mathbf{a} \pm 2(\ )$, A1: any one	M1, A1	
	$\overrightarrow{OC} = \overrightarrow{OA} \pm 2\begin{pmatrix} 1 \\ -4 \\ 9 \end{pmatrix} = \begin{pmatrix} -13 \\ -15 \\ 37 \end{pmatrix}$ or $\begin{pmatrix} -17 \\ 1 \\ 1 \end{pmatrix}$	any correct pair	A1	(4)

		(16 marks)