Question Number	Scheme	Notes	Marks
8(a)	$y = \sin^{n-1} x \cos x$ $\frac{\mathrm{d}y}{\mathrm{d}x} = (n-1)\sin^{n-2} x \cos^2 x - \sin x \sin^{n-1} x$	Achieves a derivative of the correct form (sign/coefficient errors only)	**M1**
	$= (n-1)\sin^{n-2} x(1-\sin^2 x) - \sin x \sin^{n-1} x$ $\{(n-1)\sin^{n-2} x - (n-1)\sin^n x - \sin^n x\}$ $= (n-1)\sin^{n-2} x - n\sin^n x$ *	Reaches given answer with no errors and replaces $\cos^2 x$ with $1-\sin^2 x$ <u>which must be shown</u>	**A1***
			(2)
(b)	**Note that candidates may split work over multiple lines due to the number of terms involved** $I_n = \int \mathrm{e}^{6x} \sin^n x \, \mathrm{d}x$ $u = \sin^n x \quad \frac{\mathrm{d}u}{\mathrm{d}x} = n\sin^{n-1} x \cos x \quad \frac{\mathrm{d}v}{\mathrm{d}x} = \mathrm{e}^{6x} \quad v = \frac{1}{6}\mathrm{e}^{6x}$ $I_n = \int u \frac{\mathrm{d}v}{\mathrm{d}x} \mathrm{d}x = uv - \int v \frac{\mathrm{d}u}{\mathrm{d}x} \mathrm{d}x = \frac{1}{6}\mathrm{e}^{6x} \sin^n x - \frac{n}{6}\int \mathrm{e}^{6x} \sin^{n-1} x \cos x \, \mathrm{d}x$ M1: Achieves an expression of the form $A\mathrm{e}^{6x} \sin^n x \pm B\int \mathrm{e}^{6x} \sin^{n-1} x \cos x \{\mathrm{d}x\}$ A1: Any correct expression. "dx" is not required		**M1** **A1**
	$u = \sin^{n-1} x \cos x \quad \frac{\mathrm{d}u}{\mathrm{d}x} = (n-1)\sin^{n-2} x - n\sin^n x \quad \frac{\mathrm{d}v}{\mathrm{d}x} = \mathrm{e}^{6x} \quad v = \frac{1}{6}\mathrm{e}^{6x}$ $I_n = \frac{1}{6}\mathrm{e}^{6x} \sin^n x - \frac{n}{6}\left[\frac{1}{6}\mathrm{e}^{6x} \sin^{n-1} x \cos x - \frac{1}{6}\int (n-1)\mathrm{e}^{6x} \sin^{n-2} x \{\mathrm{d}x\} + \frac{n}{6}\int \mathrm{e}^{6x} \sin^n x \{\mathrm{d}x\}\right]$ Applies parts again to obtain an expression of the correct form for I_n Some of the terms may be replaced with I_n and I_{n-2} in the intermediate working (condone sign and coefficient errors only)		**dM1**
	$I_n = \frac{1}{6}\mathrm{e}^{6x} \sin^n x - \frac{n}{36}\mathrm{e}^{6x} \sin^{n-1} x \cos x + \frac{n(n-1)}{36} I_{n-2} - \frac{n^2}{36} I_n$ Introduces I_{n-2} and I_n to an expression of the correct form		**ddM1**
	$(n^2+36) I_n = 6\mathrm{e}^{6x} \sin^n x - n\mathrm{e}^{6x} \sin^{n-1} x \cos x + n(n-1) I_{n-2}$ $\Rightarrow (n^2+36) I_n = \mathrm{e}^{6x} \sin^{n-1} x (6\sin x - n\cos x) + n(n-1) I_{n-2}$ * Obtains the printed answer <u>with intermediate step and no errors</u>. Poor bracketing can be condoned if it is recovered before the final answer. Condone missing "dx"s but there should be no missing or mixed variables		**A1***
			(5)

ALT	$I_n = \int e^{6x}\sin^n x\,dx$ $u = e^{6x}\sin^{n-1}x \quad \frac{du}{dx} = 6e^{6x}\sin^{n-1}x + e^{6x}\left[(n-1)\sin^{n-2}x\cos x\right] \quad \frac{dv}{dx} = \sin x \quad v = -\cos x$ $I_n = \int u\frac{dv}{dx}dx = uv - \int v\frac{du}{dx}dx$ $= -e^{6x}\sin^{n-1}x\cos x + \int 6e^{6x}\sin^{n-1}x\cos x + (n-1)e^{6x}\sin^{n-2}x\cos^2 x\,\{dx\}$ M1: Achieves an expression of the form $Ae^{6x}\sin^{n-1}x\cos x \pm B\int e^{6x}\sin^{n-1}x\cos x + Ce^{6x}\sin^{n-2}x\cos^2 x\{dx\}$ A1: Any correct expression. "dx" is not required	**M1** **A1**
	$u = e^{6x} \quad \frac{du}{dx} = 6e^{6x} \quad \frac{dv}{dx} = \sin^{n-1}x\cos x \quad v = \frac{1}{n}\sin^n x$ $I_n = -e^{6x}\sin^{n-1}x\cos x + \frac{6}{n}e^{6x}\sin^n x - \frac{36}{n}\int e^{6x}\sin^n x\{dx\} + \int(n-1)e^{6x}\sin^{n-2}x\{dx\} - \int(n-1)e^{6x}\sin^n x\{dx\}$ Applies parts again to obtain an expression of the correct form for I_n. Some of the terms may be replaced with I_n and I_{n-2} in the intermediate working (condone sign and coefficient errors only)	**dM1**
	$I_n = -e^{6x}\sin^{n-1}x\cos x + \frac{6}{n}e^{6x}\sin^n x - \frac{36}{n}I_n + (n-1)I_{n-2} - (n-1)I_n$ Introduces I_{n-2} and I_n to an expression of the correct form	**ddM1**
	$I_n\left(n + \frac{36}{n}\right) = -e^{6x}\sin^{n-1}x\cos x + \frac{6}{n}e^{6x}\sin^n x + (n-1)I_{n-2}$ $\Rightarrow I_n(n^2+36) = -ne^{6x}\sin^{n-1}x\cos x + 6e^{6x}\sin^n x + n(n-1)I_{n-2}$ $\Rightarrow I_n(n^2+36) = e^{6x}\sin^{n-1}x(6\sin x - n\cos x) + n(n-1)I_{n-2}$ Obtains the printed answer <u>with intermediate step and no errors</u>. Poor bracketing can be condoned if it is recovered before the final answer. Condone missing "dx"s but there should be no missing or mixed variables	**A1***
		(5)

(c)	$40I_2 = \left[e^{6x}\sin x(6\sin x - 2\cos x)\right]_0^{\frac{\pi}{6}} + 2I_0$	Applies the reduction formula with $n = 2$ Limit does not need to applied or could be missing, but "n"s should be replaced. Condone '$36 + 2^2$' for '40' on LHS	**M1**
	$I_0 = \int_0^{\frac{\pi}{6}} e^{6x}\,dx = \frac{1}{6}\left[e^{6x}\right]_0^{\frac{\pi}{6}} = \frac{1}{6}\left(e^{\pi} - 1\right)$ Or embedded, such as $I_2 = \frac{1}{40}\left(e^{\pi}\left(\frac{1}{2}\left(3-\sqrt{3}\right) + \frac{1}{3}e^{\pi}\right) - \frac{1}{40}\left(\frac{1}{3}\right)\right)$	Correct numerical expression for I_0 This may be seen embedded in a correct numerical expression for I_2	**B1**
	$I_2 = \frac{e^{\pi}}{80}\left(3-\sqrt{3}\right) + \frac{1}{120}\left(e^{\pi} - 1\right)$	Uses the limit $\frac{\pi}{6}$ and their I_0 to obtain a numerical expression for I_2 (with trig functions evaluated etc) Sight of this expression scores the first three marks	**dM1**
	$I_2 = \frac{11e^{\pi}}{240} - \frac{\sqrt{3}e^{\pi}}{80} - \frac{1}{120}$ $= \frac{1}{240}\left(e^{\pi}\left(11 - 3\sqrt{3}\right) - 2\right)$	Correct answer in the correct form. Allow $\frac{1}{240}\left(11e^{\pi} - 3\sqrt{3}e^{\pi} - 2\right)$	**A1**
			(4)

Total 11
PAPER TOTAL: 75