Question	Scheme	Marks	AOs
12(a)	$\int x^2 \mathrm{e}^{x^3}\,\mathrm{d}x = \frac{1}{3}\mathrm{e}^{x^3}\,(+c)$	M1 A1	1.1b 1.1b
		(2)	
(b)	$u = x^3 \Rightarrow \frac{\mathrm{d}u}{\mathrm{d}x} = 3x^2 \Rightarrow \int x^8 \mathrm{e}^{x^3}\,\mathrm{d}x = \int \frac{x^8 \mathrm{e}^u}{3x^2}\,\mathrm{d}u = \frac{1}{3}\int u^2 \mathrm{e}^u\,\mathrm{d}u$	M1	3.1a
	$\frac{1}{3}\int u^2 \mathrm{e}^u\,\mathrm{d}u = \frac{1}{3}u^2\mathrm{e}^u - \frac{2}{3}\int u\mathrm{e}^u\,\mathrm{d}x$	M1 A1	2.1 1.1b
	$= \frac{1}{3}u^2\mathrm{e}^u - \frac{2}{3}u\mathrm{e}^u + \frac{2}{3}\int \mathrm{e}^u\,\mathrm{d}u$	M1	1.1b
	$= \frac{1}{3}u^2\mathrm{e}^u - \frac{2}{3}u\mathrm{e}^u + \frac{2}{3}\mathrm{e}^u + c = \frac{1}{3}x^6\mathrm{e}^{x^3} - \frac{2}{3}x^3\mathrm{e}^{x^3} + \frac{2}{3}\mathrm{e}^{x^3} + c$ $= \frac{1}{3}\mathrm{e}^{x^3}\left(x^6 - 2x^3 + 2\right) + c$	A1	2.1
		(5)	
	Alternative:		
	$\int x^8 \mathrm{e}^{x^3}\,\mathrm{d}x = \int x^6 x^2 \mathrm{e}^{x^3}\,\mathrm{d}x$	M1	3.1a
	$\int x^6 x^2 \mathrm{e}^{x^3}\,\mathrm{d}x = \frac{1}{3}x^6\mathrm{e}^{x^3} - 2\int x^5 \mathrm{e}^{x^3}\,\mathrm{d}x$	M1 A1	2.1 1.1b
	$\int x^6 x^2 \mathrm{e}^{x^3}\,\mathrm{d}x = \frac{1}{3}x^6\mathrm{e}^{x^3} - 2\int x^3 x^2 \mathrm{e}^{x^3}\,\mathrm{d}x$ $= \frac{1}{3}x^6\mathrm{e}^{x^3} - 2\left[\frac{1}{3}x^3\mathrm{e}^{x^3} - \int x^2\mathrm{e}^{x^3}\,\mathrm{d}x\right]$	M1	1.1b
	$= \frac{1}{3}x^6\mathrm{e}^{x^3} - \frac{2}{3}x^3\mathrm{e}^{x^3} + \frac{2}{3}\mathrm{e}^{x^3} + c = \frac{1}{3}\mathrm{e}^{x^3}\left(x^6 - 2x^3 + 2\right) + c$	A1	2.1
			(7 marks)

Notes

(a)

M1: For $\int x^2 \mathrm{e}^{x^3}\,\mathrm{d}x = k\mathrm{e}^{x^3}\,(+c)$

A1: Correct integration (condone omission of $+ c$)

(b)

M1: Fully correct strategy for the substitution to reach an integral in terms of u only.

M1: Applies integration by parts in the correct direction on $u^2\mathrm{e}^u$

A1: Correct integral for the first application of parts

M1: Applies parts again on $u\,\mathrm{e}^u$

A1: Completes the process and obtains the correct answer in the form required

Alt:

M1: Makes the key step of writing x^8 as $x^6 \times x^2$

M1: Applies integration by parts in the correct direction

A1: Correct integral for the first application of parts

M1: Applies integration by parts again, in the correct direction, after writing x^5 as $x^3 \times x^2$

A1: Completes the process and obtains the correct answer in the form required