Question	Scheme	Marks	AOs
11	$\int 8x^2e^{-3x}\,dx = -\frac{8x^2}{3}e^{-3x} + \int \frac{16x}{3}e^{-3x}\,dx$	M1 A1	2.1 1.1b
	$= -\frac{8x^2}{3}e^{-3x} - \frac{16x}{9}e^{-3x} + \int \frac{16}{9}e^{-3x}\,dx$	**d**M1	1.1b
	$\left[-\frac{8x^2}{3}e^{-3x} - \frac{16x}{9}e^{-3x} - \frac{16}{27}e^{-3x}\right]_0^1$ $= -\frac{8}{3}e^{-3} - \frac{16}{9}e^{-3} - \frac{16}{27}e^{-3} - \left(-0 - 0 - \frac{16}{27}\right)$	M1	2.1
	$= \frac{16}{27} - \frac{136}{27}e^{-3}$	A1	1.1b
		(5)	
			(5 marks)

Notes

Mark positively in this question and do not penalise poor notation such as a missing "d*x*" or spurious integral signs, "+ *c*" etc. as long as the intention is clear.

M1: Obtains $\pm\alpha x^2e^{-3x} \pm \beta\int x\,e^{-3x}\,dx$

(you do not need to be concerned about how they arrive at this)

A1: Correct expression **simplified or unsimplified**. E.g. allow $-\frac{8x^2}{3}e^{-3x} - \int -\frac{16x}{3}e^{-3x}\,dx$

Note that we condone the "8" missing for this mark so allow e.g. $-\frac{x^2}{3}e^{-3x} - \int -\frac{2x}{3}e^{-3x}\,dx$

Note that notation may be poor here but the intention clear e.g. if they obtain $-\frac{8x^2}{3}e^{-3x} + \left[\frac{16x}{3}e^{-3x}\right]$ and then attempt to integrate $\frac{16x}{3}e^{-3x}$ both marks can be implied.

dM1: Attempts parts again on $\pm\beta\int x\,e^{-3x}\,dx$ to obtain $\pm Axe^{-3x} \pm B\int e^{-3x}\,dx$

This may be seen in isolation and does not need to be seen as part of the complete integration. **Depends on the first method mark.**
Watch for the DI method (with or without the 8):

	D	**I**
+	$8x^2$	e^{-3x}
–	$16x$	$-\frac{1}{3}e^{-3x}$
+	16	$\frac{1}{9}e^{-3x}$
–	0	$-\frac{1}{27}e^{-3x}$

Giving the correct integration e.g. $\int 8x^2e^{-3x}\,dx = -\frac{8x^2}{3}e^{-3x} - \frac{16x}{9}e^{-3x} - \frac{16}{27}e^{-3x}$

In such cases score M1dM1 for obtaining $\pm px^2e^{-3x} \pm qxe^{-3x} \pm re^{-3x}$, $p, q, r \neq 0$
and then A1 for the **correct** first 2 terms, with or without the factor of 8.
Note that for this approach M1A1dM0 is not possible.

M1: Substitutes the limits 1 and 0 into an expression of the form $\pm\alpha x^2 e^{-3x} \pm \beta x e^{-3x} \pm \gamma e^{-3x},\ \alpha, \beta, \gamma \neq 0$ and subtracts the right way round.
Must see evidence of the use of **both** limits and subtraction and use of $e^0 = 1$.
Note that some candidates apply the limits as they go e.g. to the $\left[-\frac{8x^2}{3}e^{-3x}\right]$ which is acceptable but you will need to check carefully that overall they are satisfying the conditions above.
Condone not realising that the first 2 terms evaluate to 0 when substituting $x = 0$ e.g. condone $-\frac{8}{3}e^{-3} - \frac{16}{9}e^{-3} - \frac{16}{27}e^{-3} - \left(-\frac{8}{3} - \frac{16}{9} - \frac{16}{27}\right)$ as we have evidence of $e^0 = 1$
Note that e.g. $-\frac{8}{3}e^{-3} - \frac{16}{9}e^{-3} - \frac{16}{27}e^{-3} - \left(-\frac{16}{27}e^{0}\right) = -\frac{136}{27}e^{-3} - \frac{16}{27}$ scores M0 as it suggests that $e^0 = -1$ not +1.

A1: Correct answer of $\frac{16}{27} - \frac{136}{27}e^{-3}$ but allow equivalent exact fractions and condone $\frac{16}{27} - \frac{136}{27e^3}$. Isw once the correct answer is seen.

Candidates who consistently misread $8x^2e^{-3x}$ **as** $8x^2e^{3x}$:

$$\int 8x^2e^{3x}\,dx = \frac{8x^2}{3}e^{3x} - \int \frac{16x}{3}e^{3x}\,dx$$

$$= \frac{8x^2}{3}e^{3x} - \frac{16x}{9}e^{3x} + \int \frac{16}{9}e^{3x}\,dx$$

$$\left[\frac{8x^2}{3}e^{3x} - \frac{16x}{9}e^{3x} + \frac{16}{27}e^{3x}\right]_0^1$$

$$= \frac{8}{3}e^{3} - \frac{16}{9}e^{3} + \frac{16}{27}e^{3} - \left(\frac{16}{27}\right) = \frac{40}{27}e^{3} - \frac{16}{27}$$

Scores a maximum of M1A0dM1M1A0
The main scheme can be applied similarly e.g.

M1: Attempts parts to obtain $\alpha x^2 e^{3x} - \beta\int x\,e^{3x}\,dx,\quad \alpha, \beta > 0$

A0: Not available

dM1: Attempts parts again on $\beta\int x\,e^{3x}\,dx$ to obtain $Cxe^{3x} - D\int e^{3x}\,dx,\ C, D > 0$

M1: Substitutes the limits 1 and 0 into an expression of the form $\pm\lambda x^2 e^{3x} \pm \mu x e^{3x} \pm \gamma e^{3x},\ \lambda, \mu, \gamma \neq 0$ and subtracts the right way round.
Must see evidence of the use of **both** limits and subtraction and use of $e^0 = 1$.

A0: Not available

But note, do **not** allow mixing of $3x$'s and $-3x$'s. If there are a mixture, apply the main scheme.