Question Number	Scheme	Marks
8(a)	$\frac{1}{\sqrt{4+x}} = 4^{-\frac{1}{2}}\left(1+\frac{x}{4}\right)^{-\frac{1}{2}}$	M1
	$\left(1+\frac{x}{4}\right)^{-\frac{1}{2}} = 1+\left(-\frac{1}{2}\right)\left(\frac{x}{4}\right)+\frac{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}-1\right)}{2!}\left(\frac{x}{4}\right)^2+\ldots$	M1
	$\frac{1}{2}-\frac{1}{16}x+\frac{3}{256}x^2+\ldots$	A1A1
		(4)
(b)	$\frac{1}{2}+\frac{1}{16}x+\frac{3}{256}x^2+\ldots$	B1ft
		(1)
(c)	$\left(\frac{1}{2}-\frac{1}{16}x+\frac{3}{256}x^2\right)\left(\frac{1}{2}+\frac{1}{16}x+\frac{3}{256}x^2\right)=\frac{1}{4}+\frac{1}{128}x^2$	M1A1
		(2)
(d)	$\frac{1}{\sqrt{5}}\times\frac{1}{\sqrt{3}}="\frac{1}{4}"+"\frac{1}{128}"="\frac{33}{128}"$	M1
	$"\frac{128}{33}"\times 3=\frac{128}{11}$ (see alt (d) for alternative answer)	dM1A1
		(3)
Alt(d)	$\frac{1}{\sqrt{5}}\times\frac{1}{\sqrt{3}}="\frac{1}{4}"+"\frac{1}{128}"="\frac{33}{128}"$	M1
	$\frac{1}{\sqrt{15}}\times\frac{\sqrt{15}}{\sqrt{15}}=\frac{\sqrt{15}}{15}\approx"\frac{33}{128}"\Rightarrow\sqrt{135}=3\sqrt{15}\approx 3\times 15\times"\frac{33}{128}"=\frac{1485}{128}$	dM1A1
		(10 marks)

(a) It is scored B, M, A, A on epen. We are scoring it M, M, A, A

M1: Takes out a factor of 4 proceeding to $4^{-\frac{1}{2}}\left(1+\frac{x}{4}\right)^{-\frac{1}{2}}$ o.e such as $\frac{1}{2}\times\left(1+\frac{x}{4}\right)^{-\frac{1}{2}}$

M1: Attempts the binomial expansion.

Look for the correct binomial coefficient for the **third term with the correct power of** *x*. So, award for $\frac{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}-1\right)}{2!}(\ldots x)^2$ or $\underline{\underline{\frac{3}{8}}}\times\ldots\underline{\underline{x^2}}$ where … could even be 1. If there is no intermediate working it is implied by the correct coefficient of $\frac{3}{128}x^2$ in the expansion of $\left(1+\frac{x}{4}\right)^{-\frac{1}{2}}$ or $\frac{3}{256}x^2$ in the expansion of $(4+x)^{-\frac{1}{2}}$

A1: Two correct and simplified of $\frac{1}{2}-\frac{1}{16}x+\frac{3}{256}x^2+\ldots$ So 1,0,1, 0 is possible

A1: All three correct and simplified of $\frac{1}{2}-\frac{1}{16}x+\frac{3}{256}x^2+\ldots$

Accept as a list. Condone any extra terms even if incorrect

Direct expansion: $(4+x)^{-\frac{1}{2}} = 4^{-\frac{1}{2}} + \left(-\frac{1}{2}\right)\times 4^{-\frac{3}{2}}x + \frac{\left(-\frac{1}{2}\right)\times\left(-\frac{3}{2}\right)}{2}\times 4^{-\frac{5}{2}}x^2 + ... = \frac{1}{2} - \frac{1}{16}x + \frac{3}{256}x^2 + ...$

M1: For a constant term of $4^{-\frac{1}{2}}$ or $\frac{1}{2}$

M1: For a correct third term which may be un-simplified $\frac{\left(-\frac{1}{2}\right)\times\left(-\frac{3}{2}\right)}{2}\times 4^{-\frac{5}{2}}x^2$

It is implied if they get $\frac{3}{256}x^2$ for the term in x^2

A1: Two correct and simplified of $\frac{1}{2} - \frac{1}{16}x + \frac{3}{256}x^2 + ...$

A1: All three correct and simplified of $\frac{1}{2} - \frac{1}{16}x + \frac{3}{256}x^2 + ...$

Accept as a list. Condone any extra terms even if incorrect

(b)

B1ft: For a correct answer $\frac{1}{2} + \frac{1}{16}x + \frac{3}{256}x^2 + ...$ which can be scored following a restart.

Allow as a list. Condone any extra terms even if incorrect.

Or follow through on their (a) $\alpha - \beta x + \delta x^2 + ...$ where α, β, δ are positive to (b) $\alpha + \beta x + \delta x^2 + ...$

Answers must be seen in (b).

(c)

M1: Attempts to multiply out the correct $\left(\frac{1}{2} - \frac{1}{16}x + \frac{3}{256}x^2\right)\left(\frac{1}{2} + \frac{1}{16}x + \frac{3}{256}x^2\right)$ or follow through using their answers to parts (a) and (b) and attempts to collect terms. **It must be an attempt** on $\left(\alpha - \beta x + \delta x^2\right)\times\left(\alpha + \beta x + \delta x^2\right)$ where α, β, δ are positive leading to $\alpha^2 + \kappa x^2$. Condone extra terms where the index is greater than 2, such as a term in x^4

Alternatively, attempts the expansion $\left(16 - x^2\right)^{-\frac{1}{2}} = 16^{-\frac{1}{2}}\left(1 - \frac{1}{16}x^2\right)^{-\frac{1}{2}}$ leading to $\frac{1}{4} \pm \kappa x^2$

A1: $\frac{1}{4} + \frac{1}{128}x^2$ ONLY Any extra terms would be A0. Condone = for $\approx$

(d) **This cannot be scored from made up values of *a* and *b*.**

M1: Substitutes $x = 1$ into both sides of their part (c) to achieve $\frac{1}{\sqrt{5}}\times\frac{1}{\sqrt{3}} = "\frac{1}{4}" + "\frac{1}{128}"$

dM1: Uses the fact that $\sqrt{135} = 3\times\sqrt{15}$ and finds a rational approximation for $\sqrt{135}$

Method 1: $\frac{1}{\sqrt{5}}\times\frac{1}{\sqrt{3}} = "\frac{1}{4}" + "\frac{1}{128}" \Rightarrow \frac{\sqrt{15}}{15} = "\frac{1}{4}" + "\frac{1}{128}" \Rightarrow \sqrt{135} = \left("\frac{1}{4}" + "\frac{1}{128}"\right)'\times 45$

Method 2: $\frac{1}{\sqrt{5}}\times\frac{1}{\sqrt{3}} = "\frac{1}{4}" + "\frac{1}{128}" \Rightarrow \frac{1}{\sqrt{15}} = "\frac{1}{4}" + "\frac{1}{128}" \Rightarrow \sqrt{135} = \frac{3}{\left("\frac{1}{4}" + "\frac{1}{128}"\right)'}$

The method marks M1, dM1 may be implied, e.g. by the calculation $\left("\frac{1}{4}" + "\frac{1}{128}"\right)'\times 45$ without sight of $\sqrt{135}$

A1: Either $\frac{128}{11}$ (or $11\frac{7}{11}$) or $\frac{1485}{128}$ (or $11\frac{77}{128}$) (or accept both if found)

Question Number	Scheme	Marks
9(a)	$(V)=\pi\int_0^4\left(\cos x+\frac{1}{5}\mathrm{e}^x\right)^2\,\mathrm{d}x$	B1
	$\left(\cos x+\frac{1}{5}\mathrm{e}^x\right)^2=\cos^2 x+\frac{2}{5}\mathrm{e}^x\cos x+\frac{1}{25}\mathrm{e}^{2x}$	M1
	$=\frac{\cos 2x+1}{2}+\frac{2}{5}\mathrm{e}^x\cos x+\frac{1}{25}\mathrm{e}^{2x}$	dM1
	$=\pi\int_0^4\left(\frac{1}{2}+\frac{\cos 2x}{2}+\frac{2}{5}\mathrm{e}^x\cos x+\frac{1}{25}\mathrm{e}^{2x}\right)\mathrm{d}x$	A1
		(4)
(b)	**Way I** $\int \mathrm{e}^x\cos x\,\mathrm{d}x=\pm\mathrm{e}^x\sin x\pm\int\mathrm{e}^x\sin x\,\mathrm{d}x$ $=\mathrm{e}^x\sin x-\int\mathrm{e}^x\sin x\,\mathrm{d}x$ **Way Two** $\int \mathrm{e}^x\cos x\,\mathrm{d}x=\mathrm{e}^x\cos x\pm\int\mathrm{e}^x\sin x\,\mathrm{d}x$ $=\mathrm{e}^x\cos x+\int\mathrm{e}^x\sin x\,\mathrm{d}x$	M1 A1
	$\int \mathrm{e}^x\cos x\,\mathrm{d}x=\mathrm{e}^x\cos x\pm\mathrm{e}^x\sin x-\int\mathrm{e}^x\cos x\,\mathrm{d}x$ $2\int \mathrm{e}^x\cos x\,\mathrm{d}x=\mathrm{e}^x\cos x\pm\mathrm{e}^x\sin x$	dM1
	$\int \mathrm{e}^x\cos x\,\mathrm{d}x=\frac{1}{2}\mathrm{e}^x\left(\cos x+\sin x\right)+(c)$	A1
		(4)
(c)	$\pi\int_0^4\left(\frac{1}{2}+\frac{\cos 2x}{2}+\frac{2}{5}\mathrm{e}^x\cos x+\frac{1}{25}\mathrm{e}^{2x}\right)\mathrm{d}x$ $=(\pi)\left[\frac{1}{2}x+\frac{\sin 2x}{4}+\frac{2}{5}\left(\frac{1}{2}\mathrm{e}^x\left(\sin x+\cos x\right)\right)+\frac{1}{50}\mathrm{e}^{2x}\right]_0^4$	M1A1ft
	$2\pi\left(2+\frac{\sin 8}{4}+\frac{2}{5}\left(\frac{1}{2}\mathrm{e}^4\left(\sin(4)+\cos(4)\right)\right)+\frac{1}{50}\mathrm{e}^8-\frac{11}{50}\right)$	dM1
	$=\text{awrt } 290\ (\text{cm}^3)$	A1
		(4)
		(12 marks)

(a)

B1: A correct expression for the volume including limits and dx E.g. $\pi\int_0^4\left(\cos x+\frac{1}{5}\mathrm{e}^x\right)^2\mathrm{d}x$

The correct limits may be implied by subsequent work. It can be awarded from a correct final answer (as it is not a given answer). Don't be concerned by the non- appearance of a V. Condone it being termed 'Area'

M1: Attempts to multiply out $\left(\cos x+\frac{1}{5}\mathrm{e}^x\right)^2$ leading to $\cos^2 x\pm...\mathrm{e}^x\cos x\pm...\mathrm{e}^{2x}$

dM1: Uses the identity $\cos 2x=\pm 2\cos^2 x\pm 1$. Dependent upon previous M

A1: Fully correct $\pi\int_0^4\left(\frac{1}{2}+\frac{\cos 2x}{2}+\frac{2}{5}\mathrm{e}^x\cos x+\frac{1}{25}\mathrm{e}^{2x}\right)\mathrm{d}x$