5 (a)	$\text{Vol} = \pi\int_0^{\frac{\pi}{4}} y^2 \mathrm{d}x = \pi\int_0^{\frac{\pi}{4}} \sin^2 x \,\mathrm{d}x$	M1
	$= \pi\int_0^{\frac{\pi}{4}} \frac{1}{2}(1-\cos 2x)\,\mathrm{d}x$	dM1
	$= \frac{\pi}{2}\left[x - \frac{1}{2}\sin 2x\right]_0^{\frac{\pi}{4}} = \frac{\pi}{2}\left(\frac{\pi}{4} - \frac{1}{2}\right) = \frac{\pi}{8}(\pi - 2)$ *	dM1A1 (4)
(b)	$\pi\int_0^{\frac{\pi}{4}} y^2 x \,\mathrm{d}x = \pi\int_0^{\frac{\pi}{4}} x\sin^2 x \,\mathrm{d}x$	M1
	$= \pi\int_0^{\frac{\pi}{4}} \frac{1}{2}x(1-\cos 2x)\,\mathrm{d}x$	dM1
	$= \frac{\pi}{2}\left[\frac{x^2}{2}\right]_0^{\frac{\pi}{4}} - \frac{\pi}{2}\int_0^{\frac{\pi}{4}} x\cos 2x \,\mathrm{d}x$	
	$\frac{\pi^3}{64}, -\frac{\pi}{2}\left[x \times \frac{1}{2}\sin 2x\right]_0^{\frac{\pi}{4}} + \frac{\pi}{2}\int_0^{\frac{\pi}{4}} \frac{1}{2}\sin 2x \,\mathrm{d}x$	B1,dM1
	$= \frac{\pi^3}{64} - \frac{\pi}{2} \times \frac{\pi}{8} \times 1 - \frac{\pi}{2}\left[\frac{1}{4}\cos 2x\right]_0^{\frac{\pi}{4}}$	dM1
	$= \frac{\pi^3}{64} - \frac{\pi^2}{16} - \frac{\pi}{8}(0-1) = \frac{\pi^3}{64} - \frac{\pi^2}{16} + \frac{\pi}{8} \quad (= 0.2603...)$	A1
	$\bar{x} = \left(\frac{\pi^3}{64} - \frac{\pi^2}{16} + \frac{\pi}{8}\right) \div \frac{\pi}{8}(\pi - 2) \quad = 0.5806... = 0.581$	M1A1 (8)
(c)	$\tan\theta = \dfrac{\frac{\pi}{4} - \bar{x}}{\sin\frac{\pi}{4}}$	M1
	$\tan\alpha = \dfrac{\frac{\pi}{4}}{\sin\frac{\pi}{4}}$	B1
	reqd angle $= \alpha - \theta = 48.00... - 16.12... = 31.8... = 32°$	M1A1 (4) [16]

(a)	
M1	Set up the volume integral in terms of x. π and limits not needed (ignore any shown).
dM1	Attempt to use double angles to prepare integral. Allow $\frac{1}{2}(\pm 1 \pm \cos 2x)$
dM1	Attempt integration and substitute of correct limits. Depends on previous M mark.
A1	Arrive at given result, with no errors seen. If π only appears at end, there must be some justification.
(b)	**Note:** If correct algebraic integration seen, but no evidence of use of limits, a correct final answer implies the B1 and A marks.
M1	Attempt $\int xy^2 \, dx$ in terms of x, π and limits not needed (ignore any shown)
dM1	Use double angle identity and split integral into two parts, ready for integration. Dependent on first M1.
B1	$\frac{\pi^3}{64}$ or $\frac{\pi^2}{64}$ if π cancelled
dM1	Attempt to start Integration by Parts. Dependent on previous M1.
dM1	Complete integration and substitute limits. Dependent on previous M1.
A1	Correct result (exact or decimal). Accept $\frac{\pi^2}{64} - \frac{\pi}{16} + \frac{1}{8}$
M1	Use $\bar{x} = \frac{\int xy^2 dx}{\int y^2 dx} \pi$ and ρ must be in both or neither.
A1cao	0.581 **must be 3s.f.**
Alt	Integral from (a) can be used, rather than splitting the integral
	$\int \frac{1}{2}x(1-\cos 2x)\,dx = \frac{1}{2}x\left(x - \frac{\sin 2x}{2}\right) - \frac{1}{2}\int\left(x - \frac{\sin 2x}{2}\right)dx$
	For second M1 we just need the use of the double angle identity and clear evidence of the use of the result from (a).
M1	Use their $\bar{x}$ correctly to find $\tan\theta$
B1	Correct expression for $\tan\alpha$ seen.
M1	Correct strategy (based on their $\bar{x}$) to find the required angle.
A1	32^o cao