Question Number	Answer	Mark	Additional Guidance
4a	Use of $\pi\int xy^2\mathrm{d}x\left(=\pi\int 25x-x\left(x+3\right)^2\mathrm{d}x\right)$ for moments about the *y*-axis	M1	Condone if π is missing. There must be some attempt to use the function in the question, not just quoting the general formula. E.g. $\pi\left(\int 16x-6x^2-x^3\right)\mathrm{d}x$
	Integrate as far as $\pi\left[\frac{25}{2}x^2-\frac{x}{3}\left(x+3\right)^3+\int\frac{1}{3}\left(x+3\right)^3\mathrm{d}x\right]$	M1	Or equivalent. Condone sign slips and slips in coefficients. Condone if π is missing
	Obtain $\pi\left[\frac{25}{2}x^2-\frac{x}{3}\left(x+3\right)^3+\frac{1}{12}\left(x+3\right)^4\right]$	A1	Or equivalent e.g. $\pi\left[8x^2-2x^3-\frac{1}{4}x^4\right]$
	$=\pi\left\{50-\frac{2}{3}\times125+\frac{1}{12}\times625-\frac{1}{12}\times81\right\}$ $\left(=12\pi\right)$	M1	Correct use of limits 0 and 2. Must see at least 12 or 12π. Condone if π is missing
	Complete method for centre of mass	M1	Using their moment and the given volume (if they try to work out the volume it must be correct including correct sign). Allow the π to be missing from the given volume for the M mark.
	$=12\pi\times\frac{3}{52\pi}=\frac{9}{13}$ *	A1*	Obtain **given answer** from full and correct working but allow missing d*x* throughout.
	If π is missing from the moments integral, can score M marks only unless they have also worked out the volume and explicitly shown that π cancels.		
		(6)	
4b	Use of $\frac{3r}{8}=\frac{3}{2}$	B1	Correct distance for c of m of hemisphere seen or implied.
	Moments about *AB*	M1	Or equivalent. Dimensionally correct
	$\frac{3}{2}\times\frac{128}{3}\pi-\frac{9}{13}\times\frac{52}{3}\pi=d\times\left(\frac{128}{3}-\frac{52}{3}\right)\pi$	A1	Correct unsimplified equation in *d*
	$d=\frac{39}{19}$ *	A1*	Obtain given answer from correct working. Allow with $\bar{x}$ etc. in place of *d*
			π is a common factor.

			Allow full marks if not seen.
		(4)	
4c	$\tan\theta^\circ = \frac{39}{19} \div 4 \quad \left(= \frac{39}{76}\right)$	M1	Correct use of trig to find a relevant angle. Allow for reciprocal.
	$\theta = 27$	A1	Or better 27.1649…. Must be in degrees.
		(2)	
		(12)	