Question Number	Scheme	Marks
7 (a)(i)	$V = \pi\int_1^2 \left(x^2+4\right)^2 \mathrm{d}x = \pi\int_1^2 \left(x^4+8x^2+16\right)\mathrm{d}x$	
	$= \pi\left[\frac{1}{5}x^5+\frac{8}{3}x^3+16x\right]_1^2 = \frac{613\pi}{15}\ (\mathrm{cm}^3)$ *	M1A1 A1cso
(ii)	$(\pi)\int_1^2 x\left(x^2+4\right)^2 \mathrm{d}x = (\pi)\int_1^2 \left(x^5+8x^3+16x\right)\mathrm{d}x$	
	$= (\pi)\left[\frac{1}{6}x^6+2x^4+8x^2\right]_1^2$ $\quad alt\,(\pi)\left[\frac{\left(x^2+4\right)^3}{6}\right]_1^2$	M1A1
	$\bar{x} = \dfrac{(\pi)\left[\frac{1}{6}x^6+2x^4+8x^2\right]_1^2}{\frac{613}{15}(\pi)} = \dfrac{\frac{129}{2}}{\frac{613}{15}} = 1.578... = 1.58\ (\mathrm{cm})$	M1dM1A1 (8)
(b)	Mass $\quad \frac{613\pi}{15}M \quad 9\pi M \quad 45\pi M \quad \left(36\pi+\frac{613\pi}{15}\right)M = \frac{1153\pi}{15}M$	B1
	Dist from B $\quad 0.578 \quad 0.5 \quad 0.5 \quad \bar{y}$	B1ft
	$\frac{613\pi}{15}\times 0.578 - 9\pi\times 0.5 + 45\pi\times 0.5 = \left(36\pi+\frac{613\pi}{15}\right)\bar{y}$	M1A1ft
	$\bar{y} = \frac{1249}{2306} = 0.5416... = 0.54\ \ (\mathrm{cm})$	A1 (5)
		[13]

(a)(i)M1	Attempt the squaring and integrating (at least one power going up). Allow w/o π
A1	Correct integration allow w/o π
A1*cso	Correct volume, with no errors seen. (Must include π and no $V = ...$ w/o π must have been seen.)
(ii)M1	Attempt $\int x\left(x^2+4\right)^2 dx$. Must either expand or obtain $k\left(x^2+4\right)^3$. π not needed. Limits not needed
A1	Correct algebraic integration, π not needed. Limits not needed
M1	Substitute the (correct) limits in their integrated function. Independent, but must have been attempting $\int xy^2 dx$
M1	Divide the two integrals (correct way up). Depends on the 1st and 2nd M marks. π and ρ in both or neither.
A1	Correct final result. Must be 3 sf.
	(SC Correct answer with no algebraic integration shown can score M0A0 M1 M0A0)
(b)	
B1	Correct masses seen explicitly or in an equation.
B1ft	Correct distances from *B* (or any vertical axis). Follow through distance from (a).
M1	Form a moments equation, with lighter cylinder subtracted and the heavier one added
A1ft	Correct equation, follow through their distance from (a).
A1	Correct distance from *B*, 2 sf or better

Alt (b) Find mass and CoM of S_1 first $\quad \text{Mass} = \frac{478\pi}{15}M \quad CoM = \frac{287}{478} \approx 0.6004$

Award B1B1 when all component masses and distances are seen. Complete method needed for M1.
Award first A1 for correct masses/distances initially used in forming both equations.

(Note: Use of 0.58 leads to $\bar{x} = 0.603$ (cm) for S_1. This gives a final answer 0.543. If they give 0.54, award full marks, as premature approximation does not affect final answer, but penalise 0.543)

SC – If the use *M* and 5*M* for the masses, award max B0B1 M1A0A0

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom