Question Number	Scheme	Marks	Notes
4a	<table><tr><td></td><td>H-sphere</td><td>Cylinder</td><td>Cone</td><td>S</td></tr><tr><td>Mass</td><td>$18\pi a^3$</td><td>$81\pi a^3$</td><td>$18\pi a^3$</td><td>$81\pi a^3$</td></tr><tr><td>To O</td><td>$9a+\frac{9a}{8}$</td><td>$\frac{9a}{2}$</td><td>$\frac{3a}{2}$</td><td>d</td></tr></table>	B1 B1	
	Moments about a horizontal axis through O	M1	Or a parallel axis. Dimensionally consistent. Need all terms. Condone sign errors.
	$18\times\frac{81a}{8}+81\times\frac{9a}{2}-18\times\frac{3a}{2}=81d$	A1	Correct unsimplified equation for their axis.
	$\frac{2079}{4}a=81d\Rightarrow d=\frac{77a}{12}$ *	A1*	Obtain given answer from correct working
		(5)	
4b	Moments about toppling point, or equivalent complete method	M1	Dimensionally consistent. Using $9a$ and $3a$
	$9aH=3aW\Rightarrow H=\frac{1}{3}W$	A1	
		(2)	
		[7]	
5	Moments about B	M1	Dimensionally correct. Condone sine / cosine confusion
	$Mg\times\frac{3l}{2}\sin 2\theta=T\cos\theta\times 3l$	A1 A1	Unsimplified equation in T or *their* T with at most one error. Correct unsimplified equation in T or *their* T
	$T=\frac{5Mgx}{8\times 2l}$	M1	Correct use of Hooke's Law seen or implied.
	$Mg\times\frac{3l}{2}\times 2\sin\theta\cos\theta=\frac{5Mgx}{16l}\cos\theta\times 3l$ $\left(\sin\theta=\frac{5x}{16l}\right)$	M1	Substitute for T and use double angle formula to obtain equation in x, l and θ
	$(\sin\theta=)\frac{l+\frac{1}{2}x}{3l}=\frac{5x}{16l}$	M1	Use trig to form an equation in x and l
	$\Rightarrow 16l+8x=15x\Rightarrow x=\frac{16l}{7}$ *	A1*	Obtain given answer from correct working.
		(7)	
		[7]	