Question Number	Answer	Mark
5(a)	**Take moments about the *y*-axis**, $(\pi)\int y\,x^2\,\mathrm{d}y$ with x^2 replaced in terms of y. **M0** for moments about the x-axis.	M1
	Integrate with respect to y to the form $(\pi)a^2(p\,y^2+q\,y^4)$	M1
	$=(\pi)a^2\left(\frac{9y^2}{2}-\frac{9y^4}{100a^2}\right)$	A1
	Use limits 0 and $5a$ $\pi\left(\frac{9a^2\times25a^2}{2}-\frac{9a^2\times625a^4}{100a^2}\right)$	DM1
	Complete the process to find the centre of mass	DM1
	$\left(d=\frac{9a}{30}\times\frac{25}{4}\right)\ =\frac{15}{8}a$ *	A1*
		(6)
5(b)	A complete method to obtain an equation in W and T_v only using the cone and dome.	M1
	For example, • cone and dome separately: $W\frac{5a}{2}=W\frac{15a}{8}+10aT_v$	A1
	• cone and dome combined: $2W\times\frac{5a}{16}=10aT_v$	A1
	$(T_v=)\frac{5W}{80}=\frac{W}{16}$	A1
		(4)
		(10)
	Notes for Question 5	
5(a)		
M1	Take moments about the y axis, using $(\pi)\int y\,x^2\,\mathrm{d}y$. Substitute their equation for x^2 into the correct formula. **M0 for moments taken about the *x*-axis so no further marks in (a).**	
M1	Integration with respect to y to reach the form (py^2+qy^4). Ignore constants. $\pi\int 9a^2y\left(1-\frac{y^2}{25a^2}\right)\mathrm{d}y\left(=9a^2\pi\int y-\frac{y^3}{25a^2}\mathrm{d}y\right)$	
A1	Correct integration.	
DM1	Dependent on the preceding M. Use the limits 0 and $5a$ in their integrated expression. Ignore constants. Allow if substitution of 0 is not seen.	
DM1	Dependent on both preceding M's. Divide by the given volume in a complete method. Condone consistent missing π and consistent ρ (both numerator and denominator or neither).	
A1*	Obtain given answer from correct working	
5(b)		

M1	Correct method involves an attempt to find the centre of mass of the cone or the combined solid in terms of a **and** a moments equation in W and T_v. The moments equation must be dimensionally correct with all required terms present and no extras. Accept consistent missing a's in the moments equation. Condone sign errors. If more than one equation is formed, T_p must be eliminated to earn the method mark. Alternative equations: Vert: $T_p + T_v = 2W$ M(V) combined $10aT_p = \left(10a - \frac{5}{16}a\right) \times 2W$ M(V) separate $10aT_p = \frac{30a}{4} \times W + \left(10a + \frac{15a}{8}\right)W$ M (plane face): $2W \times \frac{5a}{16} = 10aT_v$ **Note** the cone and the dome both have weight W. C of M for the model is $\frac{5a}{16}$ from the common plane face (towards the vertex of the cone).	
A1	Unsimplified equation in W and T_v with at most one error	
A1	Correct unsimplified equation	
A1	Correct answer, accept $0.0625W$	

6.

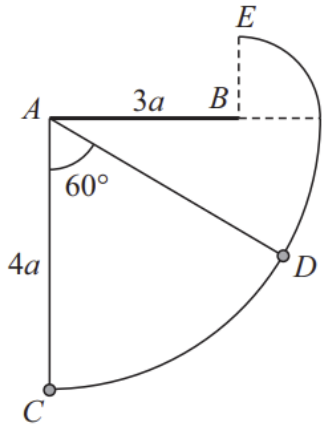


Figure 5

A thin fixed horizontal shelf AB has length $3a$.
A particle of mass m is attached to one end of a light inextensible string of length $4a$.
The other end of the string is attached to the underneath of the shelf at A.
The particle is hanging at rest at C, vertically below A, when it is projected horizontally with speed u.
The particle starts to move, with the string taut, in a vertical plane that is perpendicular to the plane of the shelf. The edge of the shelf is perpendicular to the circular path of the particle.
Air resistance is ignored.
When the string is horizontal, the string wraps round the end of the shelf and the particle continues to move in the vertical plane.
The particle follows the path CDE, as shown in Figure 5.

The point D on the circular path of the particle is such that angle $CAD = 60°$

(a) Find, in terms of m, u, a and g, the tension in the string at the instant when the particle is at D.

(5)

The point E is vertically above B, with $BE = a$.
Given that the particle is still moving in a vertical circle when it reaches E

(b) show that $u \geqslant \sqrt{11ga}$

(3)

At the instant when the particle is at E, the particle breaks free from the string.
The particle moves freely under gravity and first lands on the shelf at the point F.

Given that $u = \sqrt{12ga}$

(c) find, in terms of a, the distance BF.

(4)