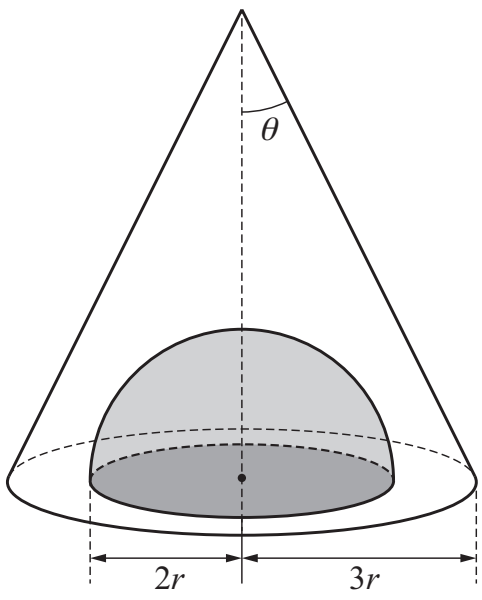
**4**




An object is formed by removing a solid hemisphere, radius $2r$, from a uniform solid cone, radius $3r$ and semi-vertical angle $\theta$, where $\tan\theta = \frac{1}{2}$. The axes of symmetry of the cone and the hemisphere coincide. The base of the cone and the base of the hemisphere are in the same plane as each other (see diagram).

**(a)** Find, in terms of $r$, the distance of the centre of mass of the object from its base. [4]

The object is placed such that its circular base makes contact with a rough plane which is inclined to the horizontal at an angle $\alpha$. The object is on the point of toppling. The plane is sufficiently rough to prevent sliding.

**(b)** Find the value of $\alpha$. [3]