

STEP II, 2004, Q9

- 9 The base of a non-uniform solid hemisphere, of mass M , has radius r . The distance of the centre of gravity, G , of the hemisphere from the base is p and from the centre of the base is $\sqrt{p^2 + q^2}$. The hemisphere rests in equilibrium with its curved surface on a horizontal plane.

A particle of mass m , where m is small, is attached to A , the lowest point of the circumference of the base. In the new position of equilibrium, find the angle, α , that the base makes with the horizontal.

The particle is removed and attached to the point B of the base which is at the other end of the diameter through A . In the new position of equilibrium the base makes an angle β with the horizontal. Show that

$$\tan(\alpha - \beta) = \frac{2mMrp}{M^2(p^2 + q^2) - m^2r^2}.$$



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