



A particle P of mass m is free to move on the smooth inner surface of a fixed hollow sphere of radius a . The centre of the sphere is O . The points A and A' are on the inner surface of the sphere, on opposite sides of the vertical through O ; the radius OA makes an angle α with the downward vertical and the radius OA' makes an angle β with the upward vertical. The point B is on the inner surface of the sphere, vertically below O . The point B' is on the inner surface of the sphere and such that OB' makes an angle 2β with the upward vertical through O (see diagram). It is given that $\cos \alpha = \frac{1}{16}$.

- (i) P is projected from A with speed u along the surface of the sphere downwards towards B . Subsequently it loses contact with the sphere at A' . Show that $u^2 = \frac{1}{8}ag(1 + 24 \cos \beta)$. [5]
- (ii) P is now projected from B with speed u along the surface of the sphere towards B' . Subsequently it loses contact with the sphere at B' . Find $\cos \beta$. [6]
- (iii) In part (i), the reaction of the sphere on P when it is initially projected at A is R . Find R in terms of m and g . [3]