7.

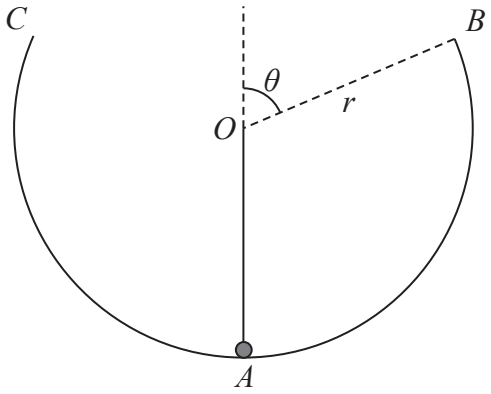


Figure 5

A thin smooth hollow spherical shell has centre O and radius r. Part of the shell is removed to form a bowl with a plane circular rim. The bowl is fixed with the circular rim uppermost and horizontal. The point A is the lowest point of the bowl, as shown in Figure 5.

The point B is on the rim of the bowl, with OB at an angle θ to the upward vertical, where $\tan\theta = \frac{12}{5}$

A small ball is placed in the bowl at A. The ball is projected from A with horizontal speed u and moves in the vertical plane AOB. The ball stays in contact with the bowl until it reaches B.

At the instant when the ball reaches B, the speed of the ball is v.

By modelling the ball as a particle and ignoring air resistance,

(a) use the principle of conservation of mechanical energy to show that

$$v^2 = u^2 - \frac{36}{13}gr$$

(3)

(b) show that $u^2 \geqslant \frac{41}{13}gr$

(4)

The point C is such that BC is a diameter of the rim of the bowl.

Given that $u^2 = 4gr$

(c) use the model to show that, after leaving the inner surface of the bowl at B, the ball falls back into the bowl before reaching C.

(6)

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