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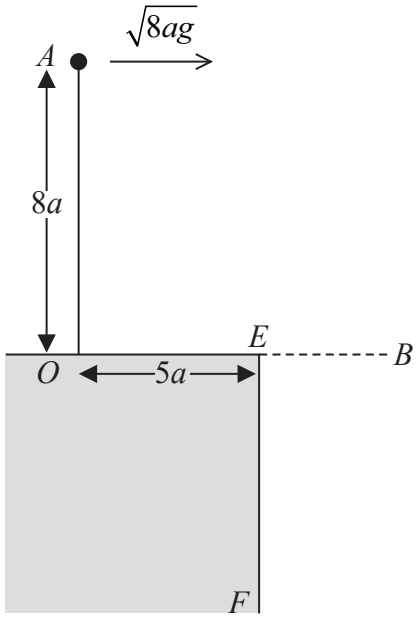


Figure 5

A particle of mass m is attached to one end of a light inextensible string of length $8a$. The other end of the string is fixed to the point O on the smooth horizontal surface of a desk. The point E is on the edge of the desk, where $OE = 5a$ and OE is perpendicular to the edge of the desk. The particle is held at the point A, vertically above O, with the string taut.

The particle is projected horizontally from A with speed $\sqrt{8ag}$ in the direction OE, as shown in Figure 5.

When the particle is above the level of OE the particle is moving in a vertical circle with radius $8a$.

Given that, when the string makes an angle θ with the upward vertical through O, the tension in the string is T,

(a) show that $T = 3mg(1 - \cos\theta)$

(7)

At the instant when the string is horizontal, the particle passes through the point B.

(b) Find the instantaneous change in the tension in the string as the particle passes through B.

(3)

The particle hits the vertical side EF of the desk and rebounds. As a result of the impact, the particle loses one third of the kinetic energy it had immediately before the impact.

In the subsequent motion the string becomes slack when it makes an angle α with the upward vertical through O.

(c) Show that $\cos\alpha = \frac{7}{12}$

(7)

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