



A billiard ball of mass M and a radius R is at rest on a billiard table. It is hit and given a sharp impulse ($= \int F dt$) due to a very large force F acting over a very short time. The impulse is horizontally directed and at a distance h above the surface of the table. The coefficient for kinetic friction between the ball and the table is μ . Note that the moment of inertia for a billiard ball about its center is $\frac{2}{5} M R^2$.

Immediately after the ball is struck, the initial velocity of the center of mass of the ball is v_0 .

For simplicity, consider only h in the range $\frac{7R}{5} > h > R$ in parts (a) and (b).

(a) Which of the following best describes the motion of the ball immediately after the impulse?

rolling without sliding,
sliding without rotating,
or, sliding and rotating

(b) As a function of h , obtain the final velocity v_f and the time t (after the blow is struck) when this final velocity is achieved (your answer may also include M , R , μ , g and v_0).

(c) Describe the motion of the ball if $h = \frac{7R}{5}$.