Answer on Question #56592, Physics Mechanics Relativity

A uniform rod of mass m and length l rests on a smooth horizontal surface. One of the ends of the rod is struck in a horizontal direction at right angles to the rod. As a result the rod obtains velocity v_0. Find the force with which one half of the rod will act the other in the process of motion.

Solution

Due to hitting of the ball the angular impulse by the rod about the $mv_0 l/2$. If ω is the angular velocity acquired by the rod. We have,

$$J\omega = \frac{mv_0 l}{2} \Rightarrow \frac{1}{12} ml^2 \omega = \frac{mv_0 l}{2} \tag{1}$$

or

$$\omega = \frac{6v_0}{l} \tag{2}$$

For the frame of C.M., the rod is rotating about an axis passing through its mid point with the angular velocity ω. Hence the force exerted by the one half on the other= mass of half ⋅ acceleration of the C.M. of that half in the C.M. frame

$$f = \frac{m}{2}\omega^2 \cdot \frac{l}{4} = \frac{m}{8}\omega^2 \cdot l = \frac{m}{8}\left(\frac{6v_0}{l}\right)^2 \cdot l = \frac{9mv_0^2}{2l}$$

Answer: $f = \dfrac{9mv_0^2}{2l}$