

Rotational Kinematics and Energy: Rotating Tip

In the Physics 211 Laboratory one group of students has decided to pursue their own experiments. They make a simple pendulum from a weight attached to a string of length L . They attach the other end of the string to a fixed support. They hold the weight with the string taut and horizontal and then released it. With their motion sensor they measure the speed of the weight as the string passes through the vertical. Remembering that all objects fall with the same acceleration, the students do a second experiment. They attach one end of a uniform stick of length L to the support, which acts as a pivot. They hold the stick horizontal and release it. They then measure the speed of the tip of the stick with their motion sensor. Do they measure the same speed?

Both situations can be treated as a conservation of energy where gravitational potential energy becomes rotational kinetic energy. The simple pendulum will have a change in gravitational potential energy equal to the length of the string; however, the rod will have a change half of that value since the center of mass of the rod is not at the tip as it is for the simple pendulum. The two set-ups also have different moments of inertia. Write a conservation of energy equation for each of the two set-ups. Solving for the translational speeds of the tips, the pendulum will measure $v = \sqrt{2gL}$

while the speed of the rod will measure $v = \sqrt{3gL}$

Therefore, the tip of the stick is faster than the pendulum.

