Problem 1

An 80 centimeter long 1 kilogram metal bar falling at 2 meters per second strikes the edge of a table as shown below. Assuming a coefficient of restitution of .9, what is the expected velocity and angular velocity of the bar after impact?

\[ v_i = 2 \text{ m/s} \]

\[ v_{Ni} = -2 \text{ m/s} \]

\[ v_{Ti} = 0 \]

\[ \omega_i = 0 \]

\[ v_{TF} = v_{Ti} = 0 \]

\[ v_{ANF} = -e v_{ANi} \]

\[ \omega = 0.9 \]

\[ v_{ANF} = 1.8 \text{ m/s} = v_{CNF} - \sqrt{\frac{\omega_i}{.4}} \]

\[ v_{CNF} = 1.8 + .4 \omega_i \]
\[ KE_i = e^2 KE_f \]

\[ \frac{1}{2} m V_{ei}^2 = (0.9)^2 \left( \frac{1}{2} m V_{NCF}^2 + \frac{1}{2} I \omega_f^2 \right) \]

\[ \frac{1}{2} (1)(-2)^2 = 0.9^2 \left( \frac{1}{2} (1)(V_{NCF}^2) + \frac{1}{2} \left( \frac{1}{12} (1)(0.8)^2 \right) \omega_f^2 \right) \]

\[ Z = 0.81 \left( \frac{1}{2} V_{NCF}^2 + 0.2667 \omega_f^2 \right) \]

Use equation solver

two solutions from equation solver

\[ \sqrt{V_{CNF}} = -1.31 \text{ m/s} \quad \Rightarrow \quad \omega_f = -7.77 \text{ rad/s} \]

\[ V_{CNF} = 2.21 \text{ m} \quad \Rightarrow \quad \omega_f = 1.02 \text{ rad/s} \]

Would involve bar bouncing up faster than it hit the surface.

After Impact

\[ V_f = 1.31 \text{ m/s} \]