21-P-WE-AG-037

A tube is bent into the shape of a quarter circle and a $m\,\frac{kg}{m}$ chain that fits precisely between the two ends of the tube is placed inside and pinned at the top. Soon afterwards, the pin is removed, and the chain begins falling out of the tube. If the chain is going $V\,\frac{m}{s}$ when it completely exits the tube, what is the radius of the quarter circle?

Hint: remember to use the centre of the chain to calculate the change in potential energy

ANSWER:

First, we write down the equation for conservation of energy.

$$T_A + V_A = T_B + V_B$$

$$\frac{1}{2}mv_a^2 + mgh_a = \frac{1}{2}mv_b^2 + mgh_b$$

Then, we input our known values.

$$0 + m \cdot \frac{1}{4} \cdot 2\pi r \cdot g \cdot \left(r\sin(45°) + \frac{1}{8} \cdot 2\pi r\right) = \frac{1}{2}m \cdot \frac{1}{4} \cdot 2\pi r \cdot V^2 + 0$$

$$g \cdot \left(r\sin(45°) + \frac{1}{8} \cdot 2\pi r\right) = \frac{1}{2}V^2$$

$$r \cdot g \cdot \left(\sin(45°) + \frac{\pi}{4}\right) = \frac{1}{2}V^2$$

$$r = \frac{V^2}{2g\left(\sin(45°) + \frac{\pi}{4}\right)}$$