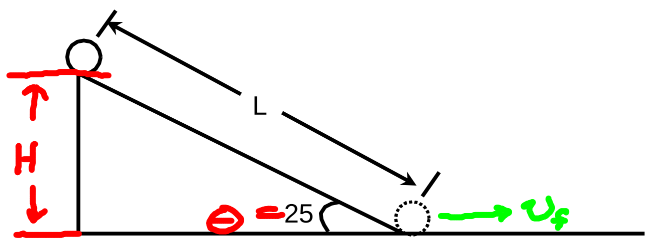
A uniform disk rolls without slipping down a ramp that is inclined at 25.0° above the horizontal. The disk starts at the top of the ramp at rest. If the ramp is 11 m long, what is the sphere's speed at the bottom of the ramp?



$H = L\sin\theta$

$\cancel{W_{nc}}^{\,0} = \Delta E$

$E_{Bottom} = E_{TOP}$

$\frac{1}{2} m v_f^2 + \frac{1}{2} I \omega_f^2 = mgH$

But $I = \gamma M R^2$ with $\gamma = 1/2$ for a Disk

$\frac{1}{2} M v_f^2 + \frac{1}{2} \gamma M (R\omega_f)^2 = mgH$

But $v_f = R\omega_f$ "No slip condition"

$\frac{1}{2}(\cancel{M} + \gamma \cancel{M}) v_f^2 = \cancel{m} g H$

$v_f^2 = \frac{2gH}{1+\gamma} \Rightarrow \boxed{v_f = \sqrt{\frac{2gH}{1+\gamma}}}$

$\gamma = 0$ sliding Block $v_f = \sqrt{2gH}$

$\gamma = 2/5$ sphere $v_f = \sqrt{\frac{2gH}{1.4}}$

$\gamma = 1/2$ cylinder $v_f = \sqrt{\frac{2gH}{1.5}}$

$\gamma = 1$ Hoop $v_f = \sqrt{\frac{2gH}{2}}$

A larger γ means more energy used for rotation so less energy remains for translation.

Alternative: γM is an effective rotational mass $\Rightarrow M_{TOTAL\,eff.} = (1+\gamma)M$