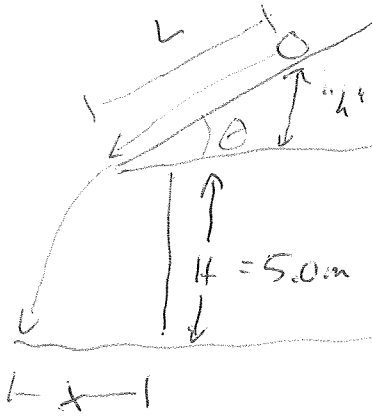
11-7 Solid cylinder ($I = \frac{1}{2}MR^2$) of $m = 12\,kg$, $R = 10\,cm$



Starts at rest and rolls $6.0\,m = L$ down the roof, $\theta = 70°$

What is it's angular speed ω when it leaves the roof?

Let's conserve energy. There are potential + kinetic energy, but kinetic comes in both motion + rotation flavors, so:

$$mgh + 0\ (KE_{motion}) + 0\ (KE_{rotation}) = \tfrac{1}{2}mv^2 + \tfrac{1}{2}I\omega^2$$

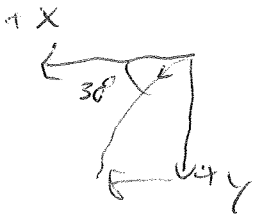
If it's rolling without slipping, $v = R\omega$ (eq. 11-2). Sub this in, also I:

$$mg(L\sin\theta) = \tfrac{1}{2}MR^2\omega^2 + \tfrac{1}{4}MR^2\omega^2 = \tfrac{3}{4}MR^2\omega^2$$

$$\text{so } \omega = \frac{1}{R}\sqrt{\frac{4}{3}gL\sin\theta} = \frac{1}{0.10\,m}\sqrt{\frac{4}{3}(9.8\,m/s^2)(3.0\,m)}$$

$$\omega = 63\ rad/s$$

b) How far does it fly? ("x" in the picture)



It starts off with $v_0 = R\omega$ in the 30° down + left direction.

$$\text{so } v_{0x} = v_0\cos 30° = (0.10\,m)(63\,rad/s)\cos 30° = 5.4\,m/s$$
$$v_{0y} = v_0\sin 30° = (0.10\,m)(63\,rad/s)\sin 30° = 3.1\,m/s$$

Projectile motion: $x = v_{0x}t$ $\quad y = v_{0y}t + \frac{1}{2}gt^2$

find time t when $y = 5.0\,m$: $t = \dfrac{-v_{0y} + \sqrt{v_{0y}^2 + 2gH}}{g} = 0.74\,s$

$$\text{so } x = v_{0x}t = (5.4\,m/s)(0.74\,s) = \boxed{4.0\,m}$$