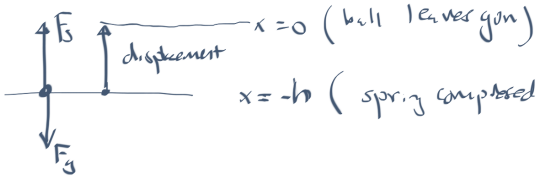
Spring gun

- the spring gun is compressed & loaded with a ball.
- As the spring moves up, the ball accelerates.
- What is the muzzle velocity?
- Use the work-kinetic energy theorem!
- Let's use $m = 100\text{grams}$ for the ball mass and $k = 10\text{N/cm}$ for the spring constant.
- Notice the new spring constant I'm using!

$$W_{total} = KE_f - \cancel{KE_i}^{0}$$

$$W_{gravity} + W_{spring} = \frac{1}{2}mv_f^2$$



$$\int_{x=-h}^{x=0} mg\overbrace{\cos\theta}^{-1}\,dx + \int_{x=-h}^{x=0} kx\overbrace{\cos\theta}^{1}\,dx = \frac{1}{2}mv_f^2$$

integrate: $-mgx\Big|_{-h}^{0} + \frac{1}{2}kx^2\Big|_{-h}^{0} = \frac{1}{2}mv_f^2$

plug in: $-mgh + \frac{1}{2}kh^2 = \frac{1}{2}mv_f^2$

Notice that the spring force does (+) work on the ball (it speeds it up), while the gravitational force does (−) work on the ball (it slows it down).

$$v_f^2 = \frac{\frac{1}{2}kh^2 - mgh}{\frac{1}{2}m} = \frac{kh^2}{m} - 2gh \approx v_f \; (= 1.9\text{m/s})$$