21-P-WE-AG-026

A new model of cannon is developed where, instead of using incendiary gunpowder, a spring is used to launch the cannonball. A *W* lb-cannonball is loaded into the cannon. Just before launch, the $k\ \frac{lb}{ft}$ spring is compressed *X* feet. The cannon is *D* feet long from the end of the compressed spring to the edge of the exit hole (when the spring is compressed, the path of the cannonball to the exit is *D* feet). If the cannon is angled θ degrees from the horizontal, how fast is the cannonball going when it exits the cannon?

Take $g = 32.2\frac{ft}{s^2}$ *in imperial.*

Hint: A lb is a unit of force, not mass.

ANSWER:

First, we write the equation for work and energy, and then we rearrange to solve for the final velocity.

$$\frac{1}{2}ks^2 - Fd = \frac{1}{2}mv_f^2$$

$$\frac{1}{2}\cdot k\cdot X^2 - W\cdot\sin(\theta)\cdot D = \frac{1}{2}\cdot\frac{W}{32.2\frac{ft}{s^2}}\cdot v_f^2$$

$$v_f = \sqrt{\left(\frac{k\cdot X^2}{W} - 2\cdot\sin(\theta)\cdot D\right)\cdot 32.2\frac{ft}{s^2}}$$