Wednesday warm-up: Forces III and Forces IV

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1 Memory Bank

- Force of drag, in air or other gas: $F_D = \frac{1}{2}C\rho A v^2$.
- In the above formula, C is an empirical constant, ρ is the density of the air or gas, A is the area of the object, and v is the object's velocity.
- Spring force: $\vec{s} = -k\Delta\vec{x}$, where k is the spring constant and $\Delta\vec{x}$ is the displacement.
- The horizontal force of friction: $\vec{f} = -\mu N\hat{i}$, where μ can be either the *static* or *kinetic* coefficient of friction.
- *Young's Modulus* relates *stress* to *strain* in a mechanical system.
- Young's Modulus, Y, has units of N m^{-2}, and it relates the change in length ΔL of a system of original length L_0 and cross-sectional area A subject to a force F:

$$\frac{\Delta L}{L_0} = \frac{1}{Y}\frac{F}{A} \tag{1}$$

2 Springs and Restoring Forces

1. Consider Fig. 1. (a) Derive an expression for the displacement of the spring from its unstretched length, given m, θ, and k. (b) Assume $m = 1.0$ kg, $\theta = 45$ degrees, and $k = 1$ N m^{-1}. What is Δx, the displacement of the spring?

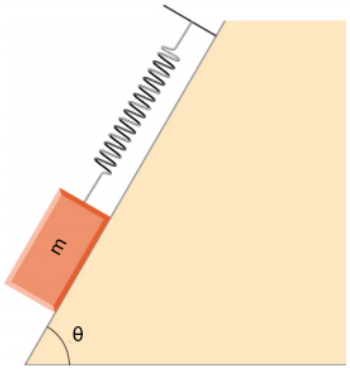

Figure 1: A spring with spring constant k supports a mass m on an incline with angle θ.

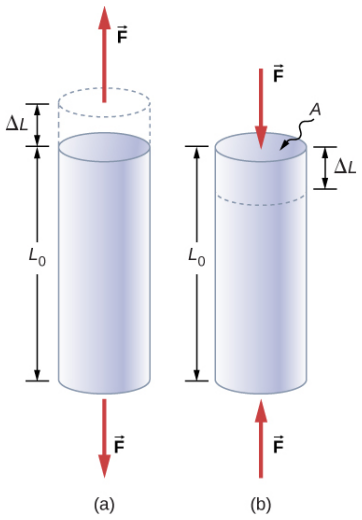

Figure 2: A spring with spring constant k supports a mass m on an incline with angle θ.

2. Consider Fig. 2. (a) The "lead" in pencils is a graphite composition with a Young's modulus of about 10^9 N m^{-2}. Calculate the change in length of the lead in an automatic pencil if you tap it straight into the pencil with a force of 4.0 N. The lead is 0.50 mm in diameter and 60 mm long. (b) Is the answer reasonable? That is, does it seem to be consistent with what you have observed when using pencils?