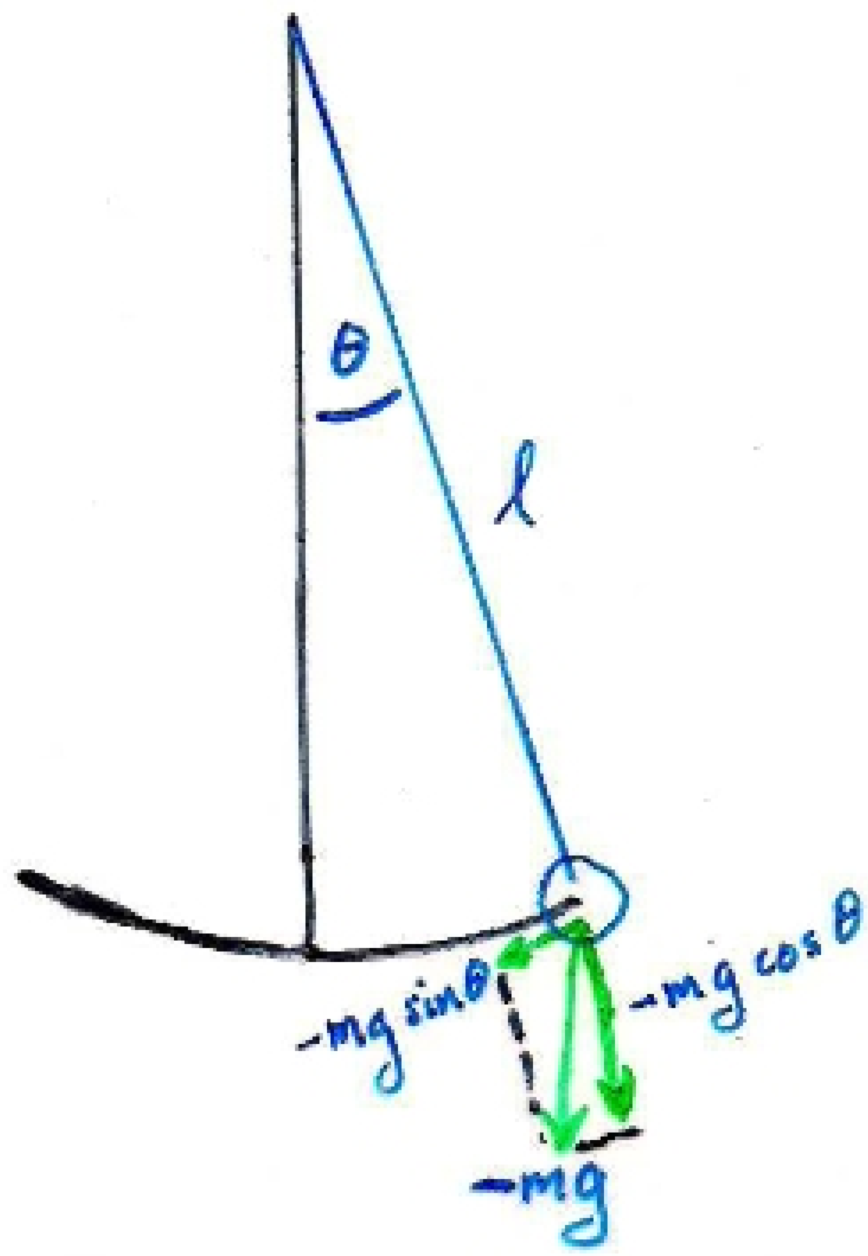
Simple Pendulum



$$-mg\sin\theta = F = ma = m\frac{d}{dt}v = m\frac{d}{dt}(l\dot{\theta}) = ml\ddot{\theta}$$

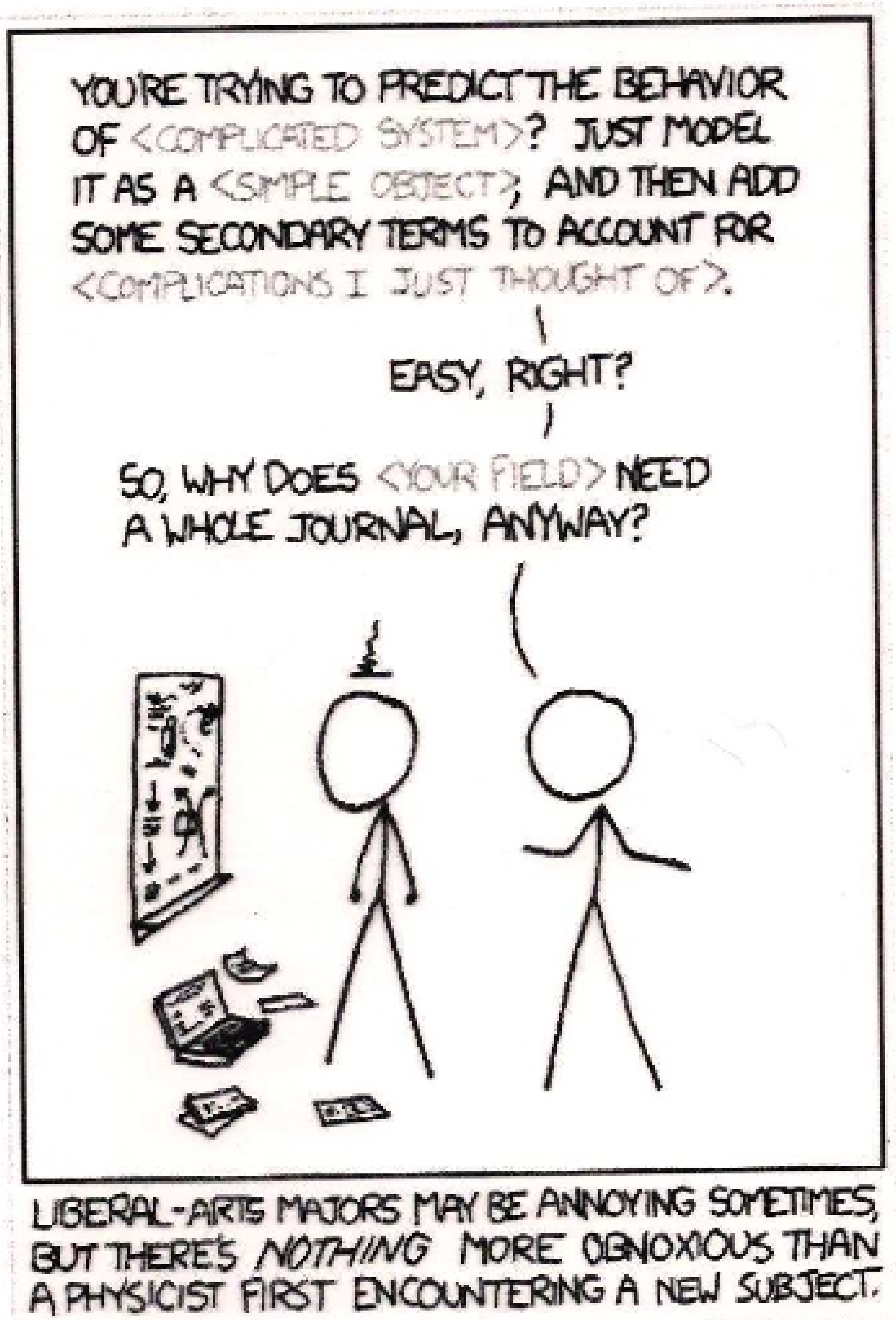
$$ml\ddot{\theta} + mg\sin\theta = 0$$

$\sin\theta \approx \theta$

$$\boxed{\ddot{\theta} + \frac{g}{l}\theta \approx 0}$$

$$\omega_0 \equiv \sqrt{\frac{g}{l}}$$

General solution: $\theta(t) = A\cos(\omega_0 t) + B\sin(\omega_0 t)$



90% of physics is the simple harmonic oscillator.
the other half is the particle in a box.

Complications

Not-so-simple harmonic motion

① Resistive force $f = -b\dot{x}$

For convenience, use $\beta \equiv \frac{b}{2m}$ so

$$f = -2\beta m \dot{x}$$

Equation of motion:

$$\ddot{x} + 2\beta\dot{x} + \omega_0^2 x = 0$$

② Driving force $F(t)$ (arbitrary form)

Then $\ddot{x} + 2\beta\dot{x} + \omega_0^2 x = \frac{1}{m}F(t)$