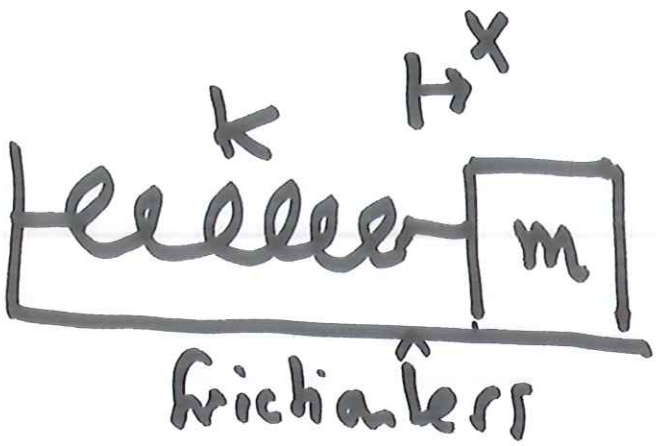
NYU Physics I — 2016-10-18

Agenda — Tutoring.

- Exam 3 scope
- Reading — Hooke's Law $\vec{F} = -k\vec{x}$, stress, strain, simple harmonic oscillator, pendulum.
- Qs
- office hours
- oscillators.

$\vec{F} = m\vec{a}$ ~~Eg~~ $F = -\frac{GMm}{r^2}$ ~~Extras~~

① 

Hooke's law:

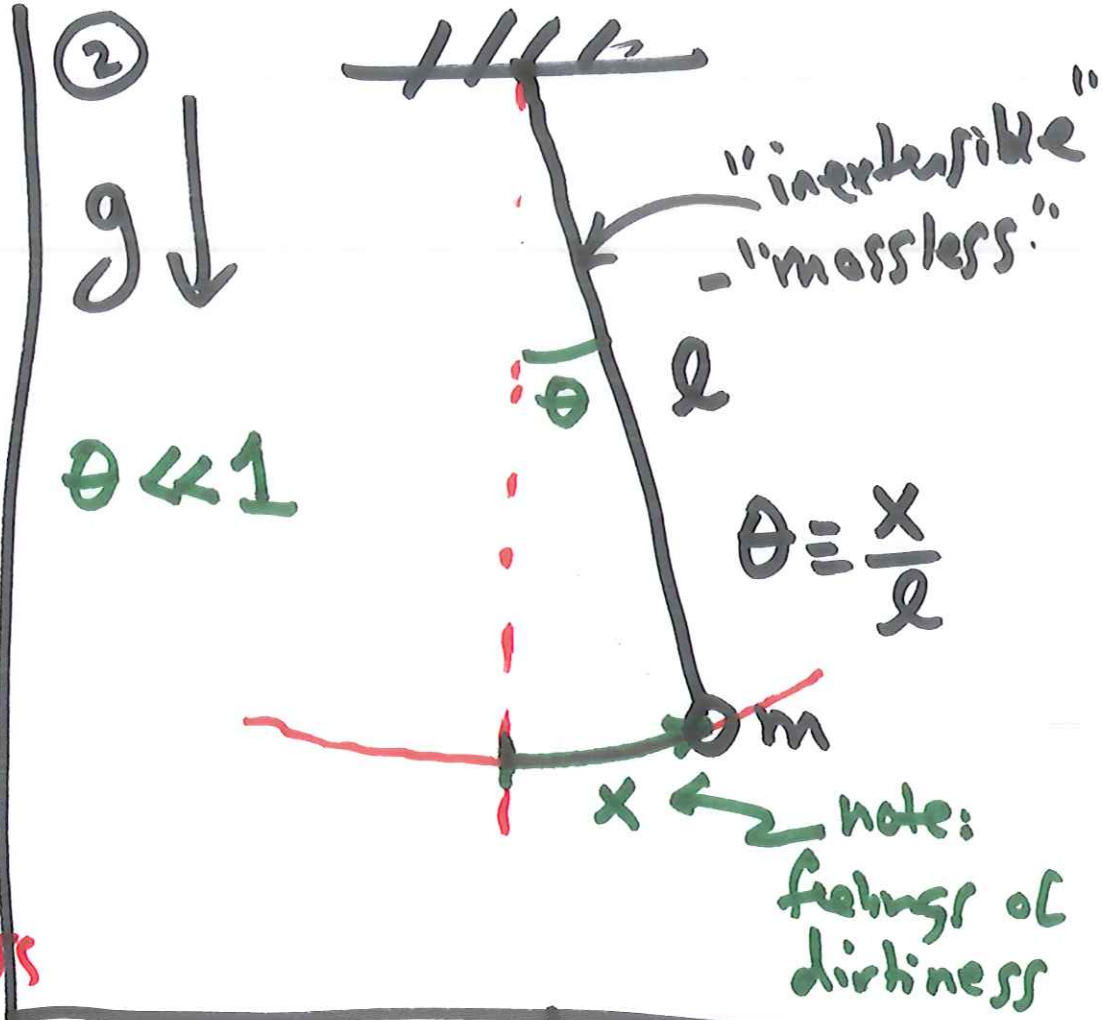
stress $\propto$ strain

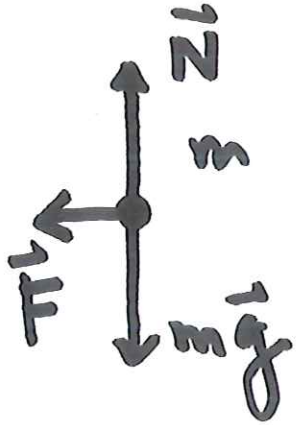
↓ ↓

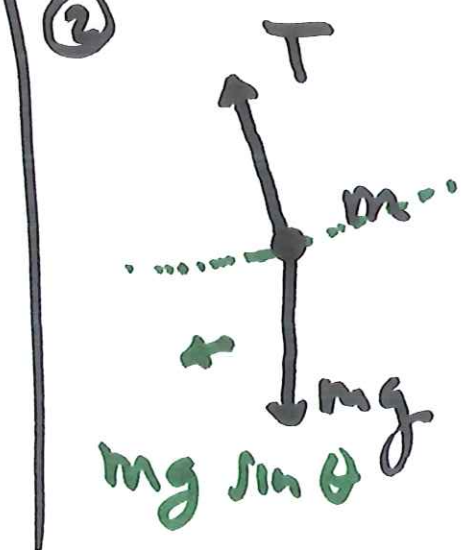
~pressure ~dimensionless distortion

For our purposes.

$$F = -kx$$

② 

① 

② 

① $F_x = -kx$

$ma_x = -kx$

$m\frac{dv_x}{dt} = -kx$

$m\frac{d^2x}{dt^2} = -kx$

$$\boxed{\frac{d^2x}{dt^2} + \frac{k}{m}x = 0}$$

② $F_x = -mg\sin\frac{x}{l}$

$m\frac{d^2x}{dt^2} = -mg\sin\frac{x}{l}$

$\frac{d^2x}{dt^2} + g\sin\frac{x}{l} = 0$ ∵ $\theta \ll 1$:

$\sin\theta = \theta - \frac{\theta^3}{3!} + \frac{\theta^5}{5!} - \frac{\theta^7}{7!} + \frac{\theta^9}{9!} - \cdots$

$$\boxed{\frac{d^2x}{dt^2} + \frac{g}{l}x = 0}$$

- homogeneous
- 2nd order
- linear

$\rightarrow x(t) = Ae^{at}$

guess: $x(t) = Ae^{\alpha t}$

$\frac{dx}{dt} = \alpha A e^{\alpha t}$ $\quad \frac{d^2x}{dt^2} = \alpha^2 A e^{\alpha t}$

$\alpha^2 A e^{\alpha t} + \frac{k}{m} A e^{\alpha t} = 0$ cool!! $\alpha^2 = -\frac{k}{m}$

guess: ~~$x(t) = A\cos\omega t + A\cos\omega t$~~

$x(t) = A\cos\omega t$

$\frac{dx}{dt} = -\omega A \sin\omega t$

$\frac{d^2x}{dt^2} = -\omega^2 A\cos\omega t$

$A\cos(\omega t + \phi)$

$A\cos\omega t + B\sin\omega t$

①

$$-\omega^2 A\cos\omega t + \frac{k}{m} A\cos\omega t = 0$$

cool!! if $+\omega^2 = +\frac{k}{m}$

$$\omega = \sqrt{\frac{k}{m}}$$

②

$$\omega = \sqrt{\frac{g}{L}}$$