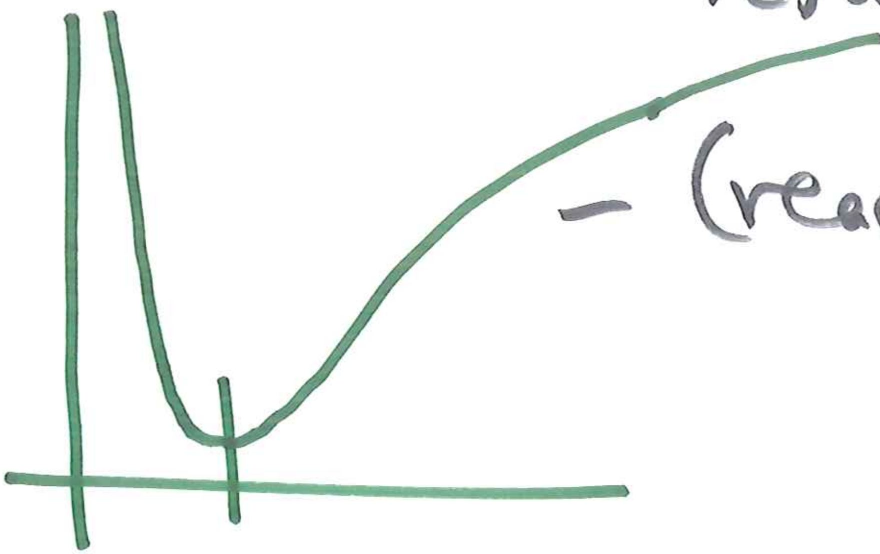
Physics I 2017-10-26

Agenda – questions

– resonance

– (reading) – resonance!

Q



$$2\pi\sqrt{\frac{\ell}{g}} = T$$

Hooke's Law — stress $\propto$ strain

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

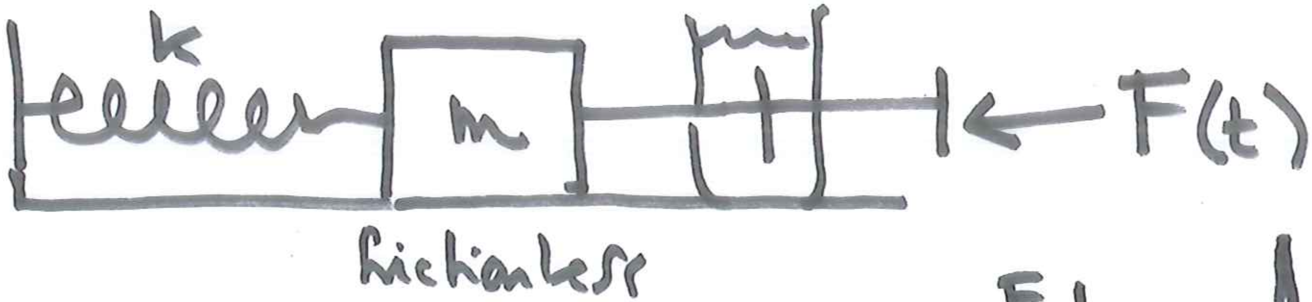
→ oscillations

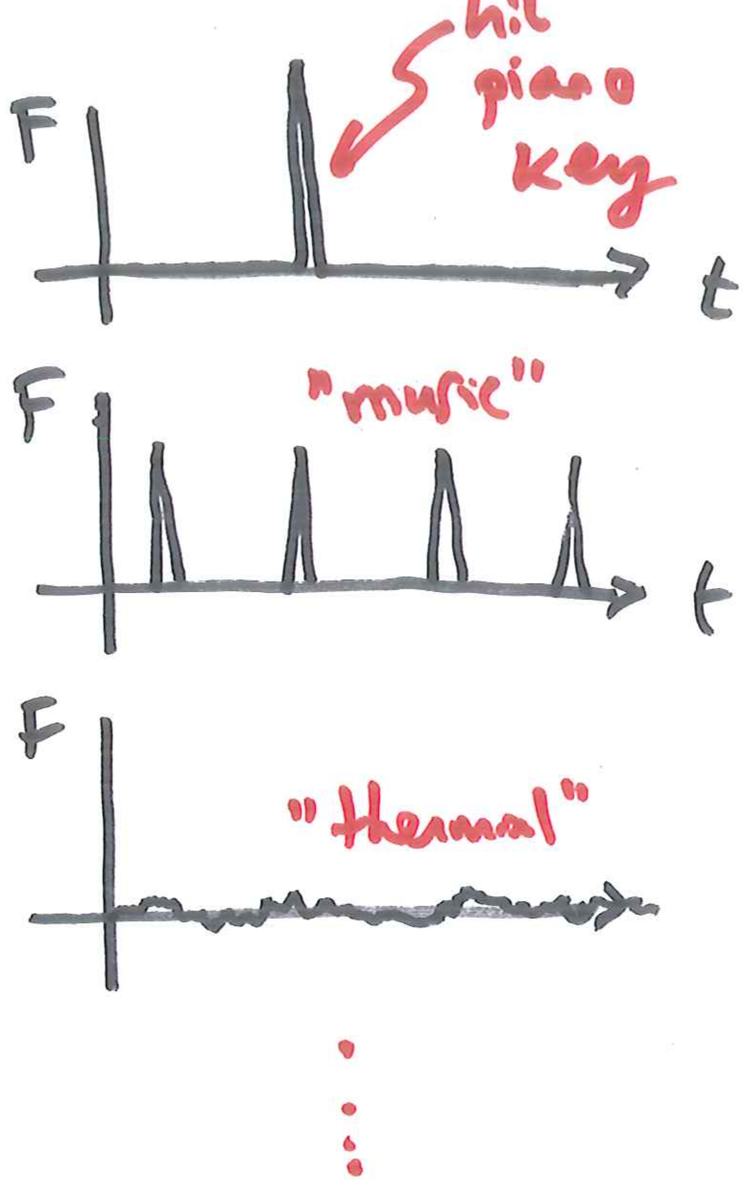
$$\underbrace{m\frac{d^2x}{dt^2}}_{\text{inertia}} + \underbrace{c\frac{dx}{dt}}_{\text{dissipation}} + \underbrace{kx}_{\text{restoring force}} = 0$$

→ exponentials (decaying)

→ oscillations (decaying)

Kleppner + Kolenkow





out of scope

ANY function F(t) can be written as a **sum** of sines & cosines.

"Fourier Transform"

$-kx - cv + F_x(t) = ma$ $\qquad \underbrace{A \cos(\nu t)}$

"nu"

$$m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = F(t) \equiv \underline{\underline{Ae^{i\nu t}}}$$

linear, ~~in~~ inhomogeneous, 2nd order $\qquad \omega$ "omega"

look for steady-state solution @ ν

guess: $x(t) = x_0 e^{i\nu t}$ $\quad \frac{dx}{dt} = i\nu x_0 e^{i\nu t}$ $\quad \frac{d^2x}{dt^2} = -\nu^2 x_0 e^{i\nu t}$

$$-m\nu^2 x_0 + ic\nu x_0 + kx_0 = A \cancel{e^{i\nu t}}$$

$$x_0 = \cancel{\frac{A}{m\ldots}} \frac{A}{\underbrace{(k - m\nu^2)} + ic\nu}$$

uh oh! - $k = m\nu^2$

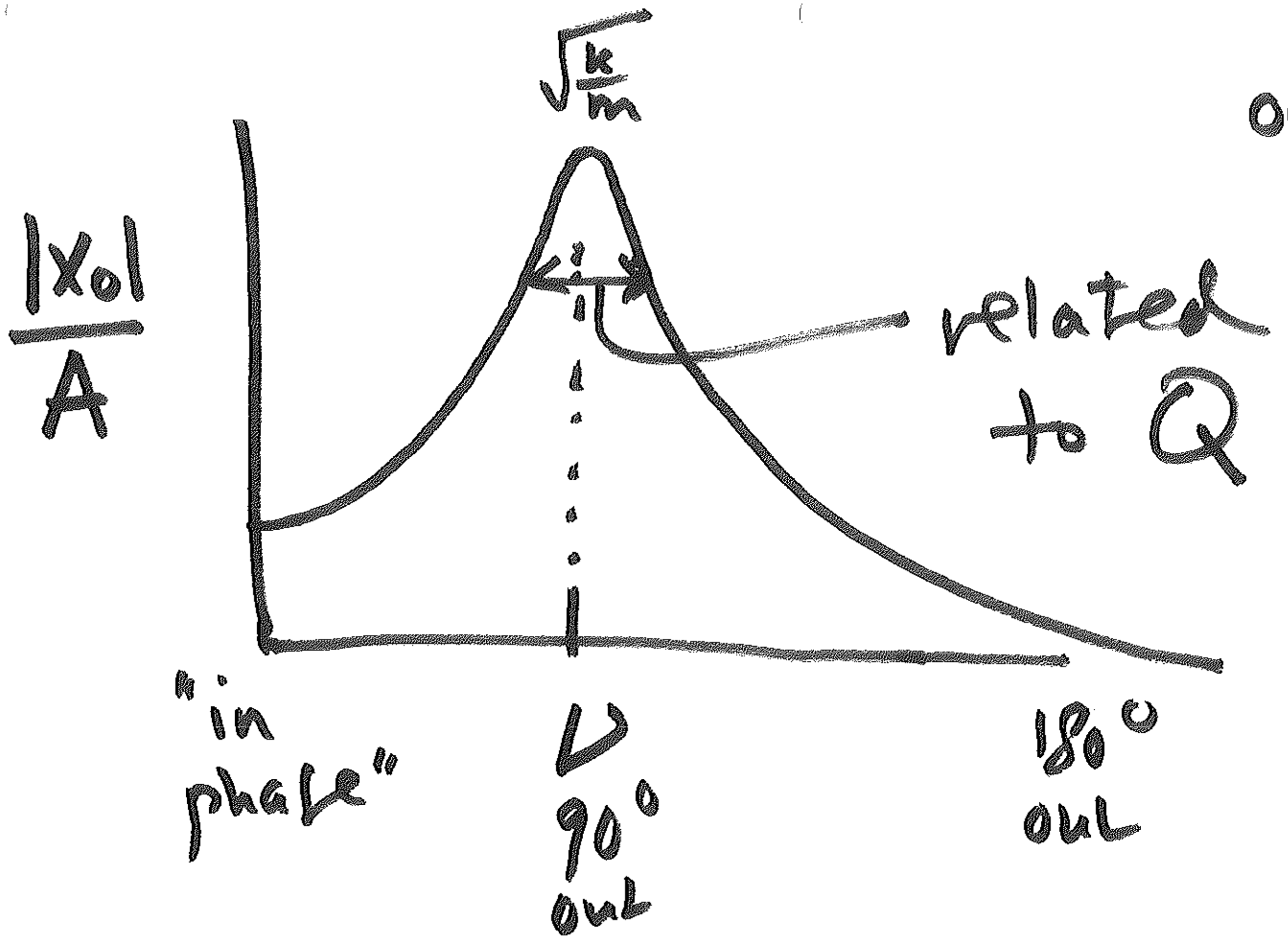
$\nu = \sqrt{\frac{k}{m}}$

$$e^{i\nu t} = \cos \nu t + i \sin \nu t$$ (trust me)

$$[a+ib]\, e^{i\nu t} = a \cos \nu t - b \sin \nu t$$

$$+ i a \sin \nu t + i b \cos \nu t$$

out of scope



$\sqrt{\frac{k}{m}}$
$\frac{|X_0|}{A}$
related to Q
"in phase"
ν
90° out
180° out