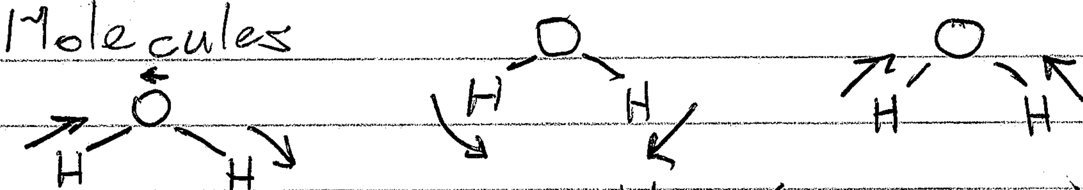
Phys 2426 2017-07-24 Lec 12

Oscillations - repetitive
- equilibrium - natural value that can be constant.
- Restoring Force
- Inertia - tendancy to "overshoot"

Examples
- Mass on a spring
- Diving board
- Pendulum
- Molecules



- Nuclei in magnetic fields (NMR, MRI)
- AC Voltage, Current
- Pieces of waves

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Describing Oscillations

Timing Period (T) - repetition time

Frequency (f) in Hz - oscillations / s

$f = 1/T$

Angular Frequency (ω) in rad/s $= s^{-1}$

$\omega = 2\pi f$

Phase (ϕ) shifts sinwave sideways

$\sin(2\pi f t + \phi)$

$\sin(\omega t + \phi)$

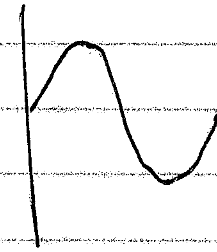
Displacement - quantity that describes the "amount of oscillation"

Ex: $x, v, a, \theta, \dot{\theta}, \alpha$, Pressure, V, I

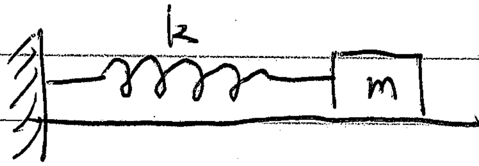
Amplitude: max value, "max" or "0" subscript

$y = y_0 \sin(2\pi f t)$

Amplitude



Simple Harmonic Oscillator - mass & Spring



no friction

m = mass

k = stiffness of spring

When spring is compressed or stretched, it fights back.

It exerts $F = -kx$

stretch of spring

So, Let $x=0$ be the mass's position when spring is "relaxed".

$$F_{net} = ma$$

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

Solution:

$$x = A\sin(\omega t + \phi)$$

$$\dot{x} = A\cos(\omega t + \phi)\,\omega$$

$$\ddot{x} = A\sin(\omega t + \phi)\,\omega(-\omega)$$

$$\ddot{x} = -\omega^2 x$$

$$-kx = m(-\omega^2 x)$$

$$\frac{k}{m} = \omega^2$$

$$\omega = \sqrt{\frac{k}{m}} \qquad 2\pi f = \sqrt{\frac{k}{m}} \qquad f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

(4)

AC in circuits

Inductor $\mathcal{E}_L = -L \frac{dI}{dt}$

Capacitor $\Delta V_c = Q/C$

Together:

$$-L\frac{dI}{dt} + Q/C = 0$$

$$-L\frac{d^2I}{dt^2} + {-I}/C = 0$$

$$-L\ddot{I} = \frac{1}{C} I$$

Compare $m\ddot{x} = -kx$