PHYS 1901 – Oscillations, Waves & Chaos

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Oscillations

eg. Simple Harmonic Motion
(purely sinusoidal)
motion that repeats periodically

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Examples

✓ – pendulum
✗ – orbits of planets – not oscillation
✓? – tides – yes at a given point
✓ – mass on spring
✗ – spinning object
✓ – liquid in U-tube
✓ – particles in sound
✓ – oscillating quartz crystal
– stars ✓

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Basic idea

• system has a stable position
least energy ≡ no net force
(equilibrium)

• displace from equilibrium and there is a force back towards equil. position (in either direction) called "restoring force"

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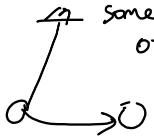
– it moves ~~back~~ towards equil posn but overshoots (arrives with some momentum) and goes ~~to~~ to other side ...



– so oscillations involve back-and-forth conversion of energy between kinetic and potential (gravitational, elastic)

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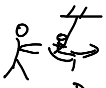
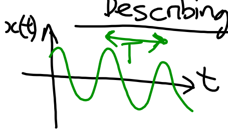
usually gradual "loss" of energy (to heat via friction) – called "damping"

can continually "put energy in" – called "driving"



Describing oscillations



x(t) is displacement

T is period of oscillation

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Also define

• frequency $f \overset{def}{=} \frac{1}{T}$ units: s^{-1} Hz

• angular frequency $\omega \overset{def}{=} 2\pi f$ units: rad s^{-1}
omega

Note: T, f & ω all have same information $\Rightarrow \omega = \frac{2\pi}{T}$

Goal: calculate $T/f/\omega$ for each oscillating system.

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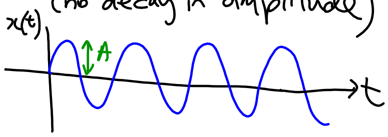
-depends on size, mass (sometimes)
g, spring, etc.

Simple Harmonic Motion

- purely sinusoidal oscillation
(no decay in amplitude)



A = amplitude
= max. displacement

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Turns out* in SHM, period ($T/f/\omega$) does not depend on amplitude

* SHM is an excellent approximation in many cases
* SHM occurs if and only if the restoring force is linearly proportional to displacement.

- Obviously, if $x(t)$ is sinusoidal, then so will be $v(t)$ and $a(t)$

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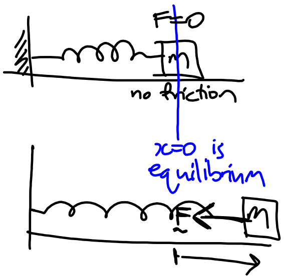
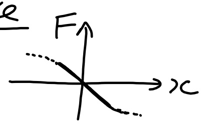
Linear restoring force





$F = -kx$
Hooke's "Law"
-approx true provided don't stretch too much
k called "spring constant"

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H/w - how does a spring work?
(what provides the force?)

Many forces are linear
($F \propto -\text{displacement}$)
$\rightarrow$ SHM

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