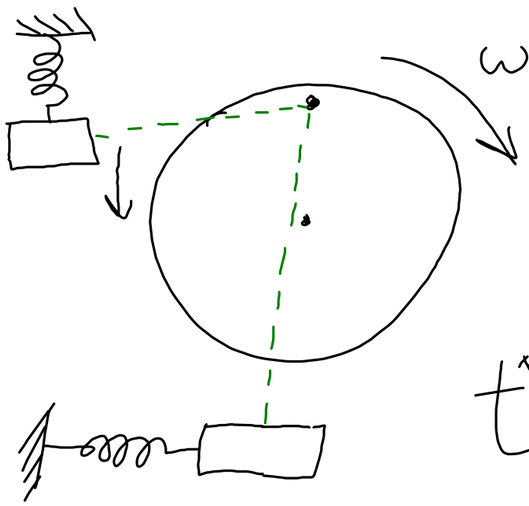
	Linear	Rotational
basic variables	t	t
	x	θ
	v	ω
	a	α
	m	I
Law of motion	$\sum \vec{F} = m\vec{a}$	$\sum \vec{\tau} = I\vec{\alpha}$
Kinetic energy	$\frac{1}{2}mv^2$	$\frac{1}{2}I\omega^2$
momentum	$\vec{p} = m\vec{v}$	$\vec{L} = I\vec{\omega}$
Work	$W = \vec{F} \cdot \Delta\vec{x}$	$W = \vec{\tau} \cdot \vec{\theta}$

skipping (read at home)

Ch. 13 - Vibrations and Waves

Oscillations — similar to rotational motion



ω (rad/s)

see SHO_referenceCircle.IP

$t^1_{\text{full rotation disk}} = t^1_{\text{full oscillation spring-mass system}}$

$\equiv$ Period (T)

$$T = \frac{2\pi}{\omega}$$

$f = \frac{1}{T}$

$T = \frac{1}{f}$

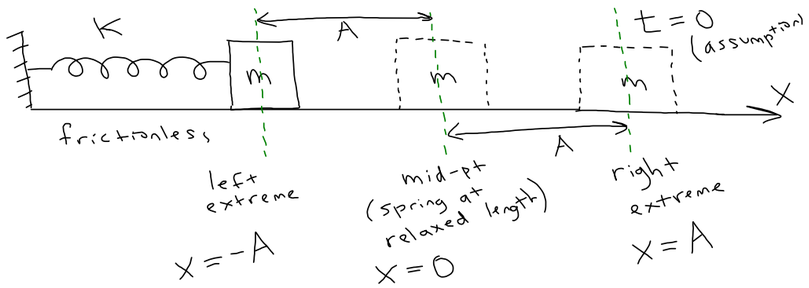
$\omega = \frac{2\pi}{T}$

etc.

$\omega = \text{rads/s}$

frequency $= f = \frac{\omega}{2\pi}$

* Redundant - if you know one then you also know the other two. (ω, f, T)



A = Amplitude

mid point to one extreme distance

$$m\frac{d^2X(t)}{dt^2} = -kX(t)$$

ODE

solution →

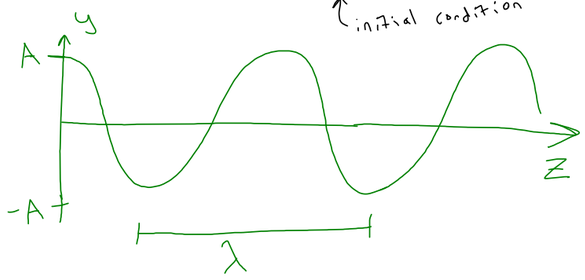
$$X(t) = A\cos\left(\sqrt{\frac{k}{m}}\,t\right)$$

(assuming $x = A$ at $t = 0$)

↑ initial condition

Aside:

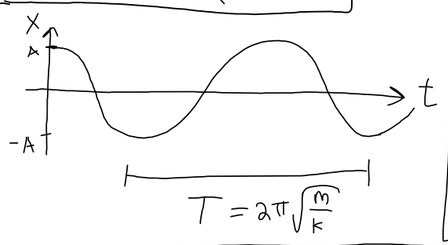
Recall from trigonometry



$$y = A\cos\left(\frac{2\pi}{\lambda}z\right)$$

Therefore, for a spring-mass system:

$$X(t) = A\cos\left(\sqrt{\frac{k}{m}}\,t\right)$$



$$T = 2\pi\sqrt{\frac{m}{k}}$$

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

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

"simple Harmonic motion"

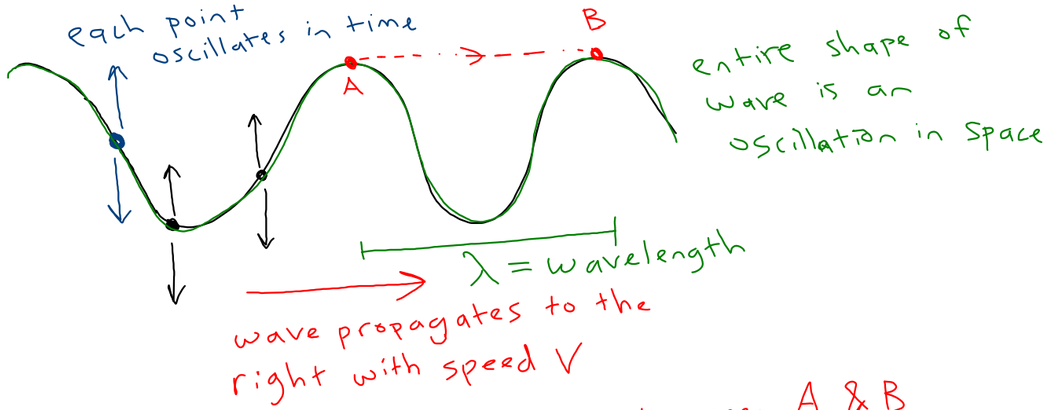
$$V(t) = -A\omega\sin(\omega t)$$

$$a(t) = -A\omega^2\cos(\omega t)$$

not constant!

$$v_f = v_i + at$$

$$v_f^2 = v_i^2 + 2a\Delta x$$

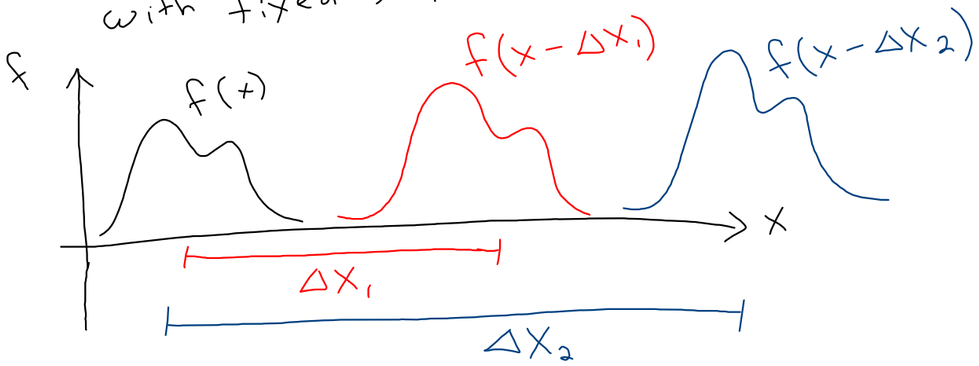


$$\text{propagation velocity} = \frac{\text{distance between A \& B}}{\text{time it takes point A to reach point B}}$$

$$\boxed{V = \frac{\lambda}{T}}$$

Traveling waves

formal definition - something that propagates with fixed shape and constant velocity



$f(x) \longrightarrow f(x + \Delta x)$

let Δx depend on time: $\Delta x = Vt$

$\Rightarrow f(x \pm Vt)$