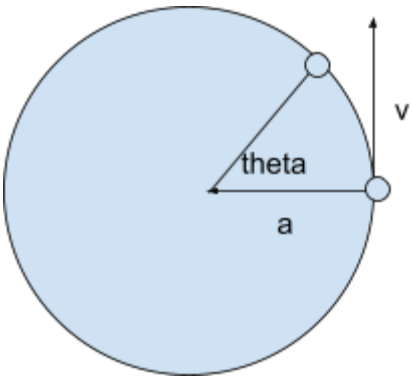
Harmonic Motion



pg.448

Springs

x = length in meters

k = spring constant = N/m = force/meters

Fnet = |kx|

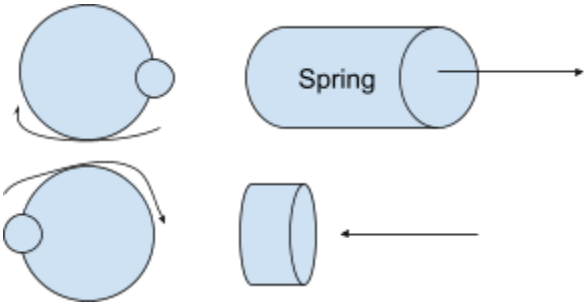
ma = kx

a = kx/m = kr/m *

U_s = 1/2kx^2

kx = mg

f = frequency = speed/wavelength



Oscillation

Position = cosx

Velocity = -sinx

Acceleration = -cosx

r = A

vmax = 2pi/T = 2πfA T = period

v = d/t = 2πr/t

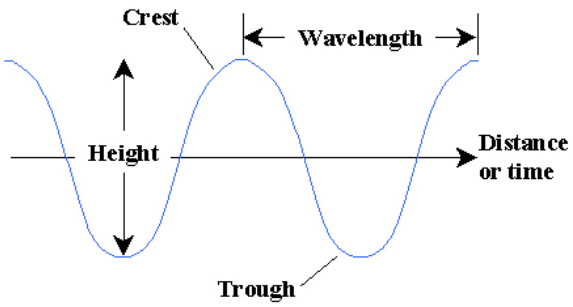
a(centripetal) = v^(2)/r = ((2πr/T)^2)/r = 4π^(2)r/T^(2) = kr/m *

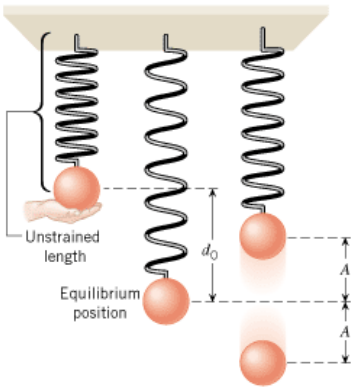
$T_s = 2\pi\sqrt{(m/k)}$

- Mass and spring constant are the ONLY factors (No care about g)
- If you have a long spring and a small spring with the same mass and spring constant, their periods will be the exact same.

(2πf) sin(2πt/T) t = time T = 1/f f = frequency(Hz)

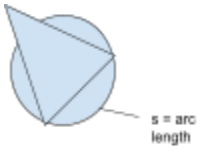
Harmonic motion = spring motion





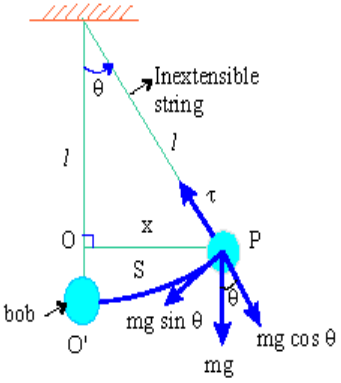
Pendulum

Fnet = mgsinθ ≈mgθ if θ < 17 degrees = mgs/r



SO...

gs/r = a = $4\pi^2 s/T^2$



T = $2\pi\sqrt{L/g}$ ONLY works for degrees < 17

Pretend perfect for all exams

!!! Only length and gravity affect

Radius (r) = Length (l)

Conditions for Pendulums

- At equilibrium (0 degrees aka the bottom) = max velocity AND kinetic energy
- At the two ends (pretty much start and end position) = max acceleration AND potential energy

Special Problem

Ratio of A

x = Acos$(2\pi rt/T)$

A is the only thing that influences amplitude

Formulas to memorize:

$xmax = A$

$x = A(cos(2\pi ft))$ A=max displacement

$vmax = 2\pi fA$

$amax = (2\pi f)^2 A$

$w = 2\pi f = 2\pi/T$

Waves

Ch.15 - Ch.16

Mechanical Waves

Wave- some form of motion

Transverse wave: perpendicular to the energy flow
Longitudinal wave: parallel to the energy flow

Frequency NEVER changes with a medium change
If frequency doesn't change, period doesn't change
Amplitude is affected by changes in the medium

Forces

Velocity -> Linear Density

$u = m/L$

Velocity -> Tension

$vstring = \sqrt{Ts/u}$ OR $\sqrt{TL/m}$

Ways to represent waves

1. A snapshot graph - the wave at a point in time (displacement over distance)
2. History graph - Flip of the snapshot graph, shows wave in chronological point (position over time)

Sinusoidal Wave - the normal way how a graph is displayed

$y(x,t) = A * cos(2\pi * (x/\lambda - t/T))$

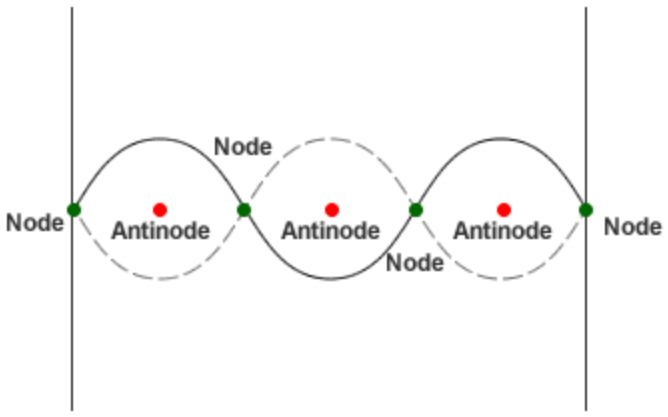
!!! Memorize !!! $\upsilon = distance / time = \lambda/T = \lambda f$

Superposition - 2 waves can go through the same point

Interference - waves interact
Constructive Interference - waves add up to point
Deconstructive Interference - waves cancel each other out ()

Standing Waves - looks as if it is standing still at certain points

!!!Standing Wave = Superposition!!!



*** DIstance between nodes = ½ wavelength

Reflections
Fixed end - flips wave; high to low speed
Standing Wave - nodes must be ends
Loose end - keeps wave; low to high speed

Modes (m) = nodes -1

Fundamental Frequency m = 1
Resonances = the frequency that the string wants to move at

$fm = m(v/2L)$

2L/m = wave length closed closed
4L/m = wavelength open close - odd modes

Less mass of molecule = greater speed

Thicker string requires more energy to move

Kahoot Notes:

The medium moves but does not travel

Sound

Like transversal waves

Compressions - small area of the sound wave
Rarefactions - larger area of the sound wave

<u>The properties of the speed of sound:</u>
Speed increases with temperature
Speed increases as molecular mass decreases

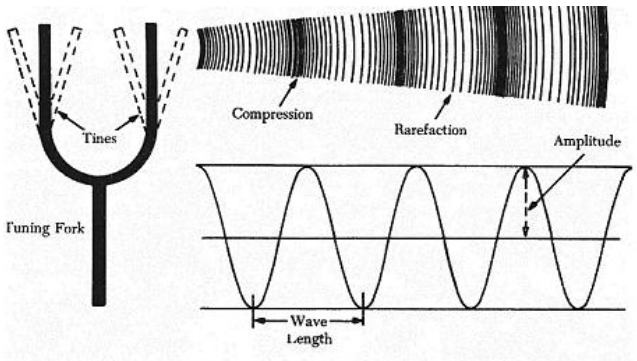
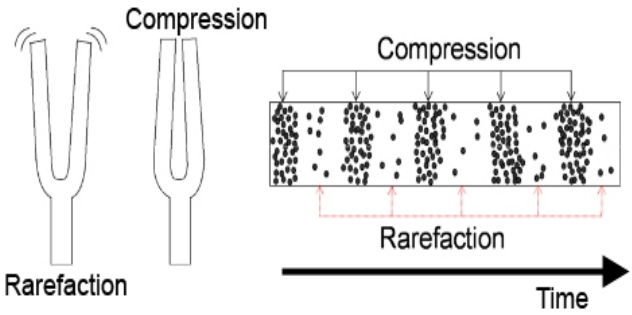


FIGURE 7–47. Sound propagation by a tuning fork.

The pressure and the density do not matter (only temp and molecular mass matter)

Pitch - FREQUENCY!!!

- Low frequency creates low pitch
  And high frequency creates high pitch



Loudness

- Perceived loudness is exponential
  Follows a logarithmic graph
  Decibel system is built around this system

Decibels

- System quantifying sound intensity

$$N_{dB} = 10 \log_{10}\left(\frac{P2}{P1}\right)$$

Resonance - a vibration at a harmonic of an object drives that object to vibrate too

Doppler Effect

As the source or the observer moves, the wavelengths seem to travel
(source is chased by its shock waves)
Echolocation: is double doppler effect

Vo > V = normal waves
-Chasing the wave
Helgemoe's car - this is the normal application of Doppler effect.

V > Vo = shock waves (not necessarily sound, but also water)
-Ahead of the wave
Breaking sound wave
Speed boat and waves

Denser materials = faster molecules
Also remember that higher temperature leads to faster molecules as well

Wavespeed = $\sqrt{tension/linear\ density}$

Linear Density = mass/length

Open end of instrument is a node

f=w/2pi

Harmonics

Integer multiples of the fundamental frequency
Standing sound waves: Area compresses and decompresses in the area. The area where the particles have the most movement, the compression is the least. And vice versa.

Standing Sound Waves

Pressure doesn't change where particles move
Pressure changes where particles don't move

Internal Pressure

Open- Open / Closed - Closed:
m 1,2,3,4,5

Open - Closed:
Odd number of modes 1,3,5,7

TImbre - difference in sound even if pitch i sthe same

Interference
Delta x = path length difference

Constructive Interference
Amplify sound
Delta r = m * λ
Destructive Interference
D = (m + 1/2) * λ wavelength
Noise cancellation

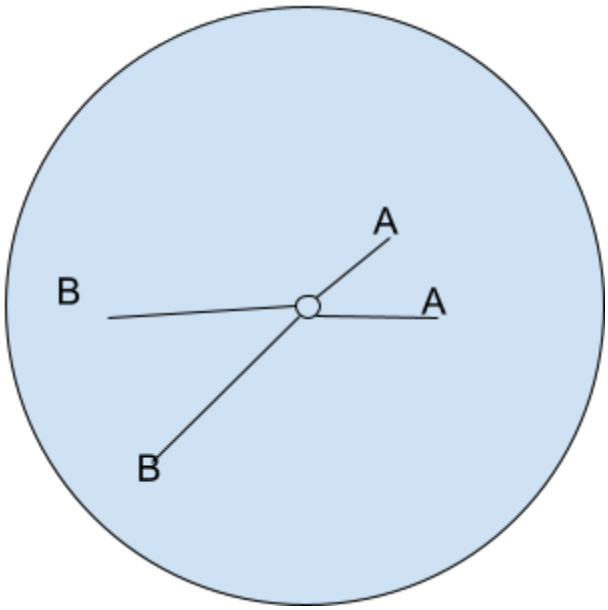
Beats in Music
Slight offset of sound waves that sometimes line up to create a beat sound

Whole number = constructive wavelength

Rotational Motion

Page. 200ish

w=change in theta/change in time



Formulas:

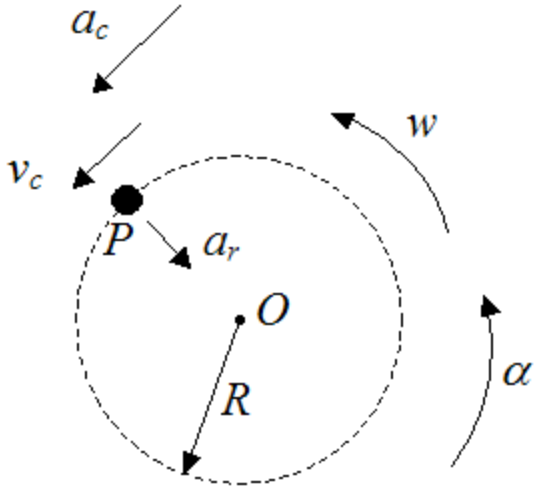
$a\,(centripetal) = v^2/r = w^2r$

$w = \Delta\theta/\Delta t$ $w = angular\ velocity$measured in rads

$\alpha = \Delta w/\Delta t$ $\alpha = angular\ acceleration$

$v = wr$

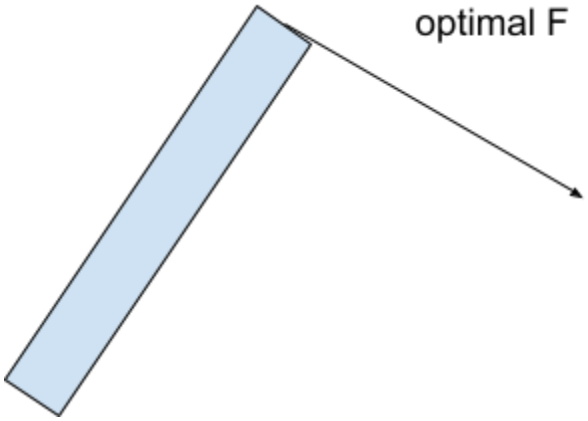
$\alpha(tangent) = \alpha r$



X_{cp} = (x1m1 + x2m2)/(m1+m2)

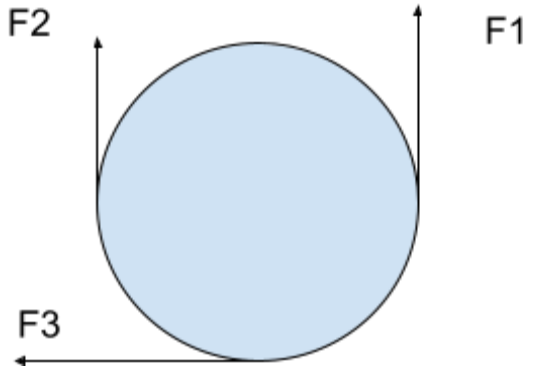
Rod stuff

Center of gravity will be located at L/2



Torque - torque, moment, or moment of force is the tendency of a force to rotate an object about an axis, fulcrum, or pivot.

τ(Torque) = r*the force perpendicular to the object
= rFsin(θ)



Torque$_{net}$ = $F_1r + F_2r + F_3r$

Clockwise-negative
Counter-Clockwise-positive

Units for Torque is on the test, know what it is. Nm newton meters

<u>Moment of Inertia</u>

*Inertia depends only on **mass**!!!*

a=F/m

$a = \alpha r$

$\alpha = F/mr$

$\alpha = \tau/I$

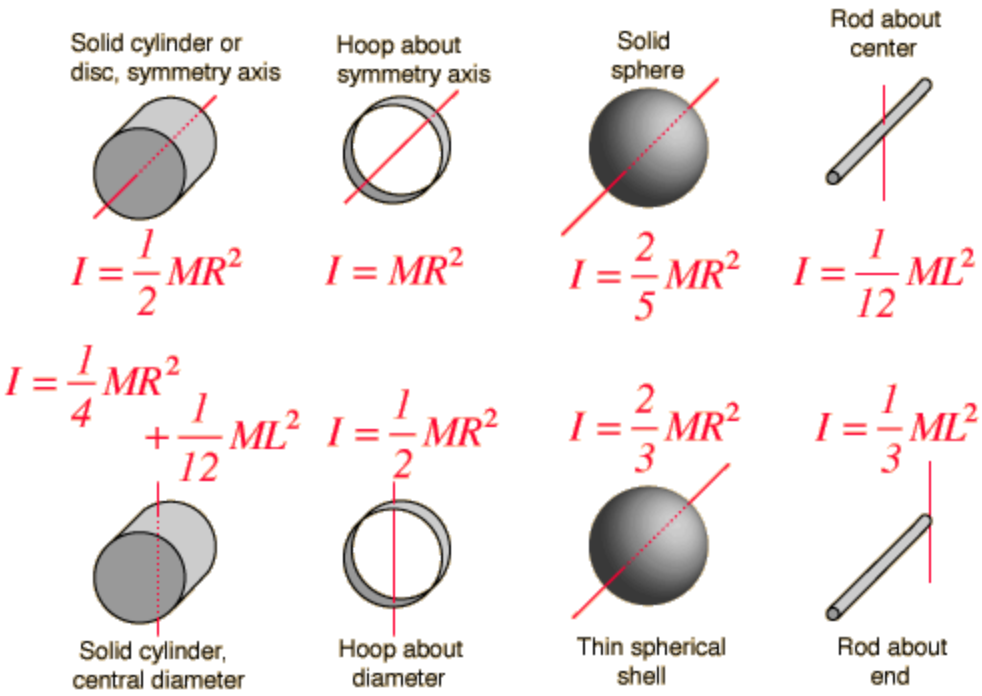
$\tau = rF$

$\alpha = \tau/mr^2$

$I = mr^2$

$L = Iw$

L = angular momentum



$L = I\omega$

$KE = 1/2\ Iw^2$

Angular units similar to Normal units

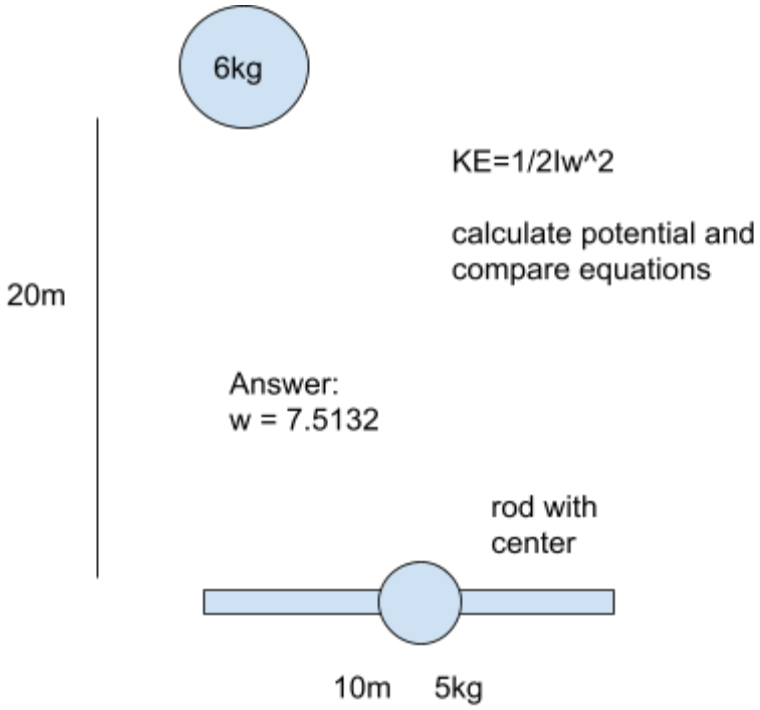
Moment of Inertia (I) like Mass (m)

Angular Velocity (w) like Velocity (v)

Conservation of Angular Momentum

Like conservation of momentum BUT with angles…

Practice Problem

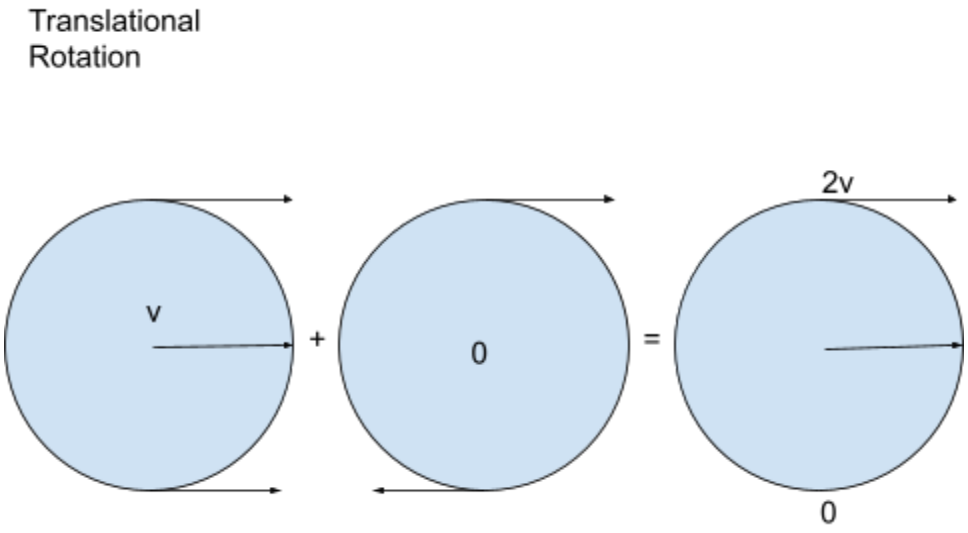


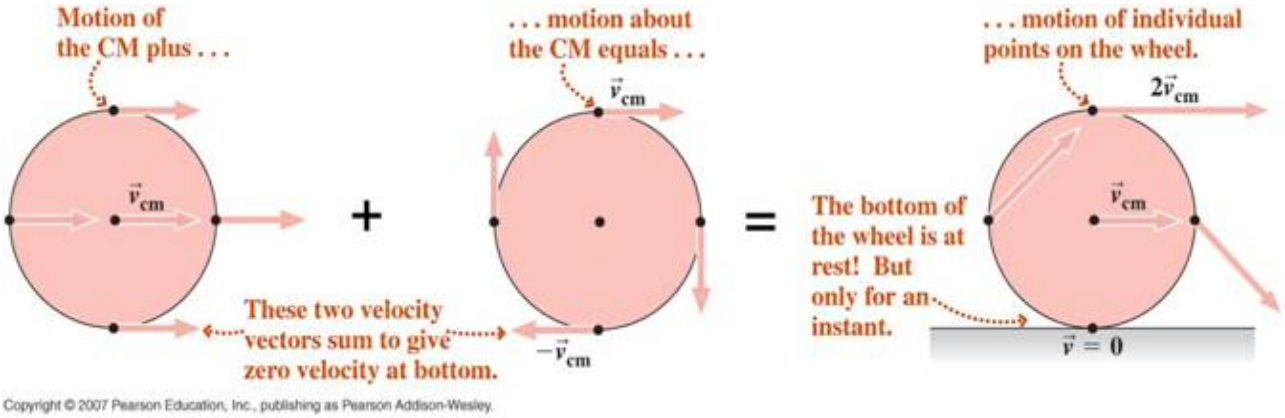
Ratio linear velocity to angular velocity

V = wr
V/w = r/1

R:1

Angular momentum is the cross product of radius and linear momentum





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Translational Motion

http://www.usd116.org/lbeuschlein/physics/powerpoint/chap2_3_4.pdf
5 day review marathon

- ➢ Scalar vs. Vector
- Scalar has no direction.
- Vectors can be separated into x and y components.
- ➢ Mass vs Weight
- Mass (Scalar): Measures the amount of matter in an object
- Weight (Vector): How gravity affects an object
- ➢ Distance vs. Displacement
  Displacement is the difference between start and end, while distance is total Traveled

Momentum (EZ$$)

- ❖ Impulse = adding force to an object over time, adding momentum to the system
- ❖ Collisions are either elastic or inelastic
  - ➢ For elastic, add masses together to calculate (p = mv = (m1+m2)v)
  - ➢ Kinetic energy is not conserved in an inelastic collision
- ❖ Area under Force/Distance graph = work
- ❖ Constant Velocity = No change in potential or kinetic energy
  - ➢ Therefore if a force is applied to an object over a distance, but the velocity is kept constant, that force is not doing any work ON the object
- ❖ Potential energy always measures the potential energy between two systems, or two masses, instead of on the object itself.

Momentum	**Energy**
Vector	Scalar
Change in p = Impulse	Change in E = work
F * t	F * d
Conserved	Conserved (Except for KE)