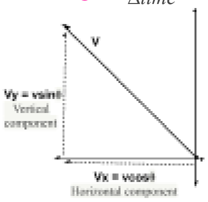
-- Physics Final --

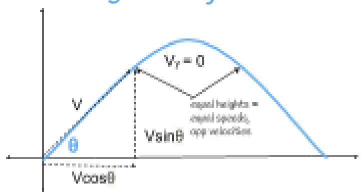
Speed: $\frac{\Delta distance}{\Delta time}$

Acceleration: $\frac{\Delta velocity}{\Delta time}$

Velocity: $\frac{\Delta position}{\Delta time}$



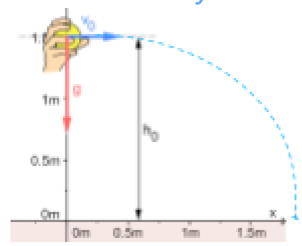
Angular Projectile



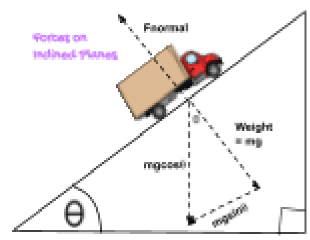
☆ Vx = vcos θ ☆ Vy = vsin θ – gt

☆ greatest horizontal Δx is at 45°

Horizontal Projectile:



☆ $t = \sqrt{\frac{2h}{g}}$ ☆ $\Delta x = v_i\sqrt{\frac{2h}{g}}$



No V_i: $\Delta x = V_f t - \frac{1}{2}at^2$

No V_f: $\Delta x = V_i t + \frac{1}{2}at^2$

No Δx: $V_f = V_i + at$

No a: $\Delta x = (\frac{V_i + V_f}{2})t$

No t: $V_f^2 = V_i^2 + 2a\Delta x$

Rotational Kinematics

Revolution: # of rev = $\frac{\theta}{2\pi}$; 1 rev = $2\pi r$

Angular Displacement: $\theta f - \theta i$

Linear Displacement (s):

$S = r\theta$; r: radius, s: arc length

Angular Velocity (ω):

$\omega = \frac{angular\ displacement}{time} = \frac{\Delta\theta}{t}$ rad/s

Linear Speed = v = rω

Energy (Rotational)

Kinetic Energy of Rotation: K = $\frac{1}{2}Iw^2$

K = $\frac{1}{2}Iw^2 = \frac{1}{2}mv^2$

Work = ω = ΔK; $\tau\theta = \Delta L$

Frθ = K = $\frac{1}{2}Iw_f^2 - \frac{1}{2}Iw_i^2$

Torque: $\tau = Frsin\theta$ Nm

$\Sigma F = ma;\ \Sigma T = I\propto$;

$\propto = \frac{\Delta w}{t} = \frac{w_f - w_i}{t}$ rad/ s^2

$\Delta\theta = \omega_i t + \frac{1}{2}\propto t^2$

$\Delta\theta = \omega_f t - \frac{1}{2}\propto t^2$

$w_f^2 = w_i^2 + 2\propto\Delta\theta$

$w_f = w_i + \propto t$

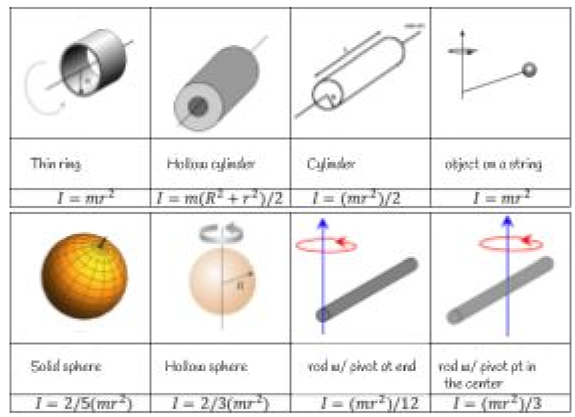
$\Delta\theta = (\frac{w_i + w_f}{2})t$

Conservation of Angular Momentum

Angular Momentum: L = Iω (kg · m/s) = mvr

Angular Impulse: J = Torque x time = Tt = ΔL

☆ Momentum is conserved $L_i = L_f$



Law of Inertia: object resists change in velocity

Force: ΣF = ma

*ΣFx = Fcos θ – Ffric

*ΣFy = Fsin θ + Fnorm – Fg

Force Friction: Ff = μFn

Centripetal Force: force in, toward object

Centrifugal Force: tendency of an object to move in a straight line vs circular motion

☆ $a_c = \frac{v^2}{r}$ ☆ ΣF = ma = $\frac{mv^2}{r}$

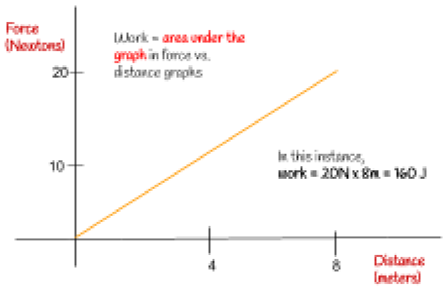
☆ T = $\frac{2\pi r}{v}$ ☆ v=2πrf

Work

W = W = Fd = μFd = mgh

Positive Work: force in direction of motion

Negative Work: force opposite of motion



Power

Power: P = $\frac{Work}{Time} = \frac{Fd}{t} = \frac{mad}{t}$ = Fv

Or P = $\frac{\Delta\ Energy}{\Delta\ Time}$ (watts)

Energy

Kinetic Energy: K = $\frac{1}{2}mv^2$

Gravitational Potential Energy: U = mgh

Work-Energy Theorem: W = ΔK

Hooke's Law: F = -kx; W = $\frac{1}{2}kx^2$

Elastic Potential Energy: Uelastic = $\frac{1}{2}kx^2$

Conservation of Energy

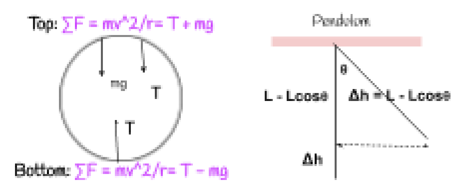
Law of Conservation of Energy: total energy is always conserved, just changes form

Mech. Energy = Kinetic + Potential

Kinitial + Uinitial = Kfinal + Ufinal

Kinitial + Uinitial + Wnc = Kfinal + Ufinal

Wnc = ΔK + ΔU; Wnc is work due to nonconservative/dissipative forces



Momentum

Momentum: ρ = mv (kg $\frac{m}{s}$ or Ns)

Impulse: Δρ = force x time = J (Ns)

Δρ =Ft = mΔv

Law of Conservation of Momentum:

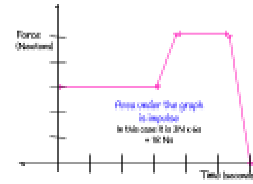
$\rho_1 = \rho_2 = m_1v_1 = m_2v_2$

Elastic Collisions: KE & ρ is conserved

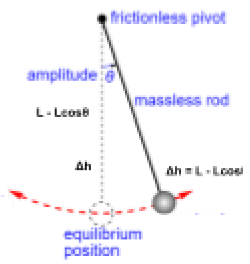
Inelastic Collision: KE is not conserved

Perfectly Inelastic Collision; objects stick together and move as one

$\rho_1 = \rho_2 = m_1v_1 = (m_1 + m_2)v_2$



Pendulums



$T = 2\pi\sqrt{\frac{L}{G}}$ (sec)

f: $\frac{1}{T}$ (Hz)

Mass-Spring System

Hooke's Law: F = -kx

k: spring constant

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

Oscillation Equation

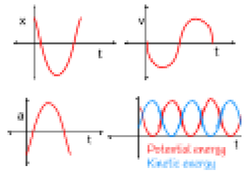
$x(t) = A\cos(wt + \Phi)$

x(t): position at time t

A: amplitude of the oscillation

ω = $\frac{2\pi}{t}$; Φ phase constant

Mass over time



✱**Springs in parallel**

KE = $K_1 + K_2$

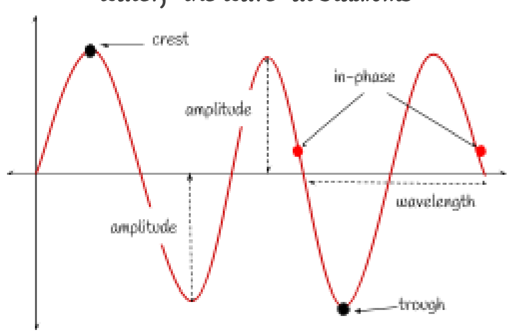
✱**Springs in series**

$\frac{1}{KE} = \frac{1}{K_1} + \frac{1}{K_2}$

Waves

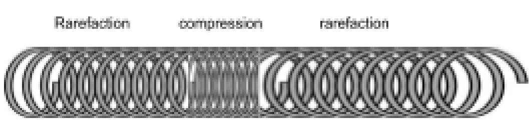
Medium: substance through which mechanical waves travel

Transverse Waves: waves that move perpendicular to wave motion *ripples in the water, "the wave" at stadiums



Longitudinal Waves: move parallel to wave motion

In-Phase: pt that has same amplitude & velocity



$T = \frac{wavelength}{wave\ speed}$ $f = \frac{1}{T}$

Wave Speed: $v = \frac{\lambda}{t} = f\lambda$ (m/s)

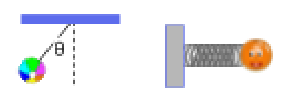
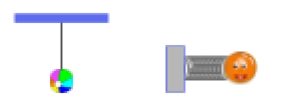
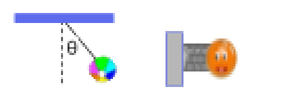
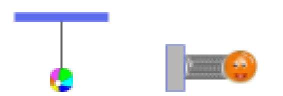
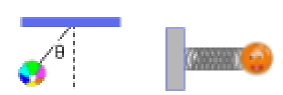
☆ the speed of a wave depends on the medium it travels through, frequency never changes though

Doppler Effect

$f' = f(\frac{v \pm v_0}{v \mp v_s})$

f': frequency heard f: actual frequency v_0 : velocity of listener when approaching source v_s : velocity of source as approaching listener

Properties of Pendulum Oscillation

	Time	x(t)	v(t)	a(t)	PE	KE
	$t_1 = 0$	left / stretched	0; Δ in direction	Max, positive	0	max
	$t_2 = \frac{t}{4}$	equilibrium	Max positive	0; Δ in direction	max	0
	$t_3 = \frac{t}{2}$	right / compressed	0; Δ in direction	Max, negative	0	max
	$t_4 = \frac{3t}{4}$	equilibrium	Max, negative	0; Δ in direction	max	0
	$t_5 = t$	left / stretched	0; Δ in direction	Max, Positive	0	max

When waves change mediums

Reflection: the wave bounces off the boundary btw the old & new medium
✱ waves reflect at a free boundary
✱ waves reflect & invert at fixed boundary

Refraction: wave's path is changed because wave speed changes

Diffraction: wave spreads out in circular path after going through a hole or barrier

Destructive Interference: a positively displaced & negatively displaced wave crash into each other (no wave)

Constructive Interference: 2 waves displaced in same dir. (bigger wave)

Standing Wave: a wave interferes with its' own reflected wave

Node: destructive interference pt

Antinode: constructive interference pt

Sound

✱ warmer and denser something is, the faster sound travels

✱ frequency ~ pitch

Beat Frequency: f (beat) = | f2 - f1 |

Intensity: power per area

$\frac{power}{area} = \frac{power}{4\pi r^3}$ W/m^2

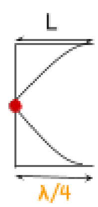
Inverse Square Law: $I \propto \frac{1}{distance^2}$

Closed Tube

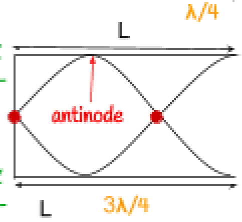
L= n(λ/4) λ= $\frac{4L}{n}$ f= $\frac{nv}{4L}$

n: harmonic # (odd)

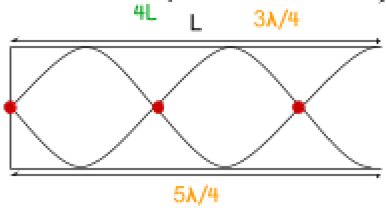
First Harmonic (fundamental frequency)
λ = 4L f = $\frac{v}{4L}$



Third Harmonic
λ = 4L/3 f = $\frac{3v}{4L}$



Fifth Harmonic
λ = 4L/5 f = $\frac{5v}{4L}$

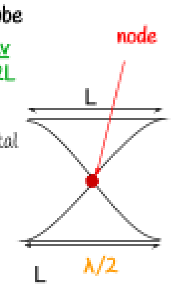


Open Tube

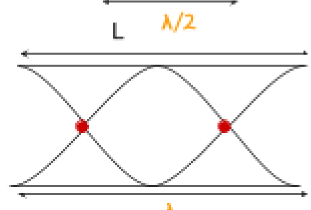
L= n(λ/2) λ= $\frac{2L}{n}$ f= $\frac{nv}{2L}$

n: harmonic # (odd)

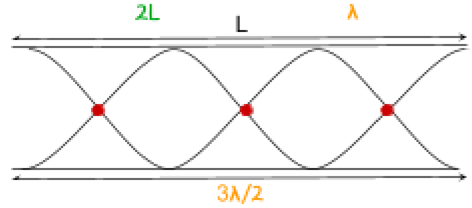
First Harmonic (fundamental frequency)
λ = 2L f = $\frac{v}{2L}$



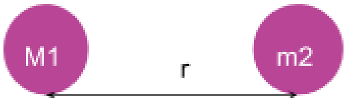
Second Harmonic
λ = L f = $\frac{v}{L}$



Third Harmonic
λ = 2L/3 f = $\frac{3v}{2L}$



Gravity



$$F = \frac{Gm_1m_2}{r^2}$$

✻ **Mass:** is not affected by gravitational force

✻ **Weight:** the amount of gravitational force an object entices (depends on planet the object is on)

✻ **Gravitational mass:** the attractive force of an object on other masses

✻ **Inertial Mass:** a measurement of an object's ability to resist any change in velocity; measured with $F = ma$ $\quad g = \frac{GM}{r^2}$

M: mass of planet (Earth's is 5.97 x $10^{24} kg$)

r: radius of planet

g: acceleration due to gravity on planet

G: gravitational constant (6.67 x 10^{11} $\frac{Nm^3}{kg}$)

✻ **Gravitational Fields:** the vector fields face towards the object, closer an object is towards a planet, the more gravity it will experience

Gravitational Potential Energy:

$$U_g = \frac{-GMm}{r}$$

✻ **Escape Velocity:** $v = \frac{2GM}{r}$

Orbital motion

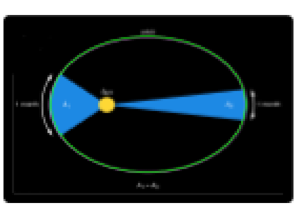
✻ Centripetal force pulls objects in

$$F_C = F_G = \frac{mv^2}{r} = \frac{GMm}{r^2}$$

$$v^2 = \frac{GM}{r}\ ;\ v = \sqrt{\frac{GM}{r}}$$

$$T = \frac{2\pi r}{v}$$

✻ **Kepler's 1st Law:** Planets orbit the sun in an ellipse path & the sun is one of the foci



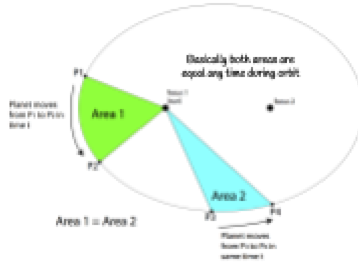
Moment of Inertia = mr

Angular Momentum = mvr

☆ Angular Momentum is conserved

mv1r1 = mv2r2

✻ **Kepler's 2nd Law:**



✻ Kepler's 3rd Law: square of the period of orbit is equal to orbit's radius cubed

$$T^2 \Leftrightarrow r^3$$

Charge: ✻ $e = 1.6 \times 10^{-19} Coulombs\ (C)$

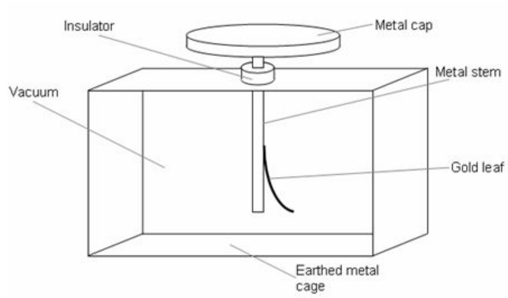
✻ Rubbing a glass rod with silk; electrons move from glass rod to silk which negatively charges the silk & positively charges the glass rod

✻ nucleus is held by strong nuclear force

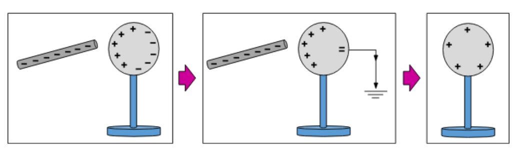
✻ 2 like charges placed together will have increasing velocity, but negative acceleration

Electroscope: measures electricity

✻ charge from a rod transfers to electroscope thus giving the electroscope same sign charge as the rod



Induction: charging of conductors w/o physical contact w/ another charged object



Net Charge = # of electron – # of proton

$$F = \frac{kq_1q_2}{r^2}$$

k= $9 \times 10^9 Nm^2/c^2$ $\quad$ r: distance

q: magnitude of each charge

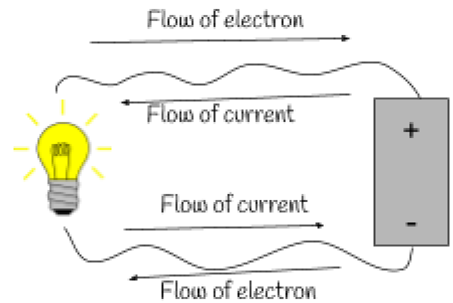
Electric Fields: dec. as distance inc; dir. of field is dir. of force exerted on + charge

✻ electrostatic force is repulsive & stronger while gravitational is attractive & weaker

Circuits

$current = \frac{charge}{time}$ $\quad I = \frac{Q}{t}$ $\quad amperes\ (A)$

✻ current travels from high to low electric potential (positive to negative charge)



Ohm's Law: $\Delta V = IR$ (graph if linear)

Series: R(total) = R1 + R2

Parallel: $\frac{1}{R(total)} = \frac{1}{R1} + \frac{1}{R2}$ ✻

Ammeters measure current in series and have low resistance (ideally none)

✻ **Voltmeters** measure voltage in parallel and ideally have infinite resistance

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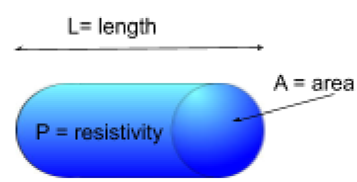
Resistivity

R = pl / A



✻ Work by electric potential: **W=Vq**

Power = $\frac{Work}{time} = \frac{Vq}{t}$ = VI = I^2R

Internal Resistance: $V = \frac{\varepsilon}{r+R}R$