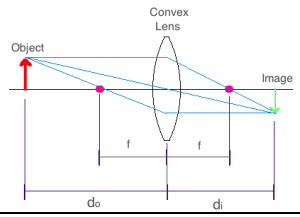
Harold's Physics Formulas
Cheat Sheet
22 October 2026

	Mechanics: Linear Translation	Mechanics: Angular / Rotational Motion	Electricity / Magnetism	Fluid Mechanics / Thermodynamics	Atomic and Nuclear / Waves and Optics
Kinematics	**Bold** = Vector **Red** = Calculus Purple = Memorize	See Harold's Physics Units of Measure Cheat Sheet See Harold's Physics of Projectiles Cheat Sheet		See Harold's Physics Optics Cheat Sheet See Math and Greek Symbols	
Position (m) (rad)	*Horizontal:* $x = x_0 + v_{0x}t + \frac{1}{2}at^2$ *(constant acceleration)* *Vertical:* $y = y_0 + v_{0y}t - \frac{1}{2}gt^2$ *(up is +)* $\Delta x = x_f - x_0$ $x = x_0 + vt$ *(constant velocity)* $x(t) = x_0 + \int_{t_0}^{t} v\,dt$	*Circular:* $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$ *(constant ang. accel.)* $\theta = \theta_0 + \dot{\theta}_0 t + \frac{1}{2}\ddot{\theta} t^2$ $\Delta\theta = \theta_f - \theta_0$ $\theta = \theta_0 + \omega t$ *(constant angular velocity)* $\theta(t) = \theta_0 + \int_{t_0}^{t} \omega\,dt$	$10^{-30} = quecto-$ $10^{-27} = ronto-$ $10^{-24} = yocto-$ $10^{-21} = zepto-$ $10^{-18} = atto-$ $10^{-15} = femto-$ $10^{-12} = pico-$ $10^{-9} = nano-$ $10^{-6} = micro-$ $10^{-3} = milli-$ $10^{-2} = centi-$ $10^{-1} = deci-$ $10^{0} = 1$ $10^{1} = deca-$ $10^{2} = hecto-$ $10^{3} = kilo-$ $10^{6} = mega-$ $10^{9} = giga-$ $10^{12} = tera-$ $10^{15} = peta-$ $10^{18} = exa-$ $10^{21} = zetta-$ $10^{24} = yotta-$ $10^{27} = ronna-$ $10^{30} = quetta-$	*Fluid Mechanics:* $\Delta\ell = \alpha\ell_0\Delta T$	*Optics:* $f = \frac{v}{\lambda}$ $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$ ***Refraction:*** *(bend)* $n = \frac{c}{v}$ *Snell's Law:* $n_1 \sin\theta_1 = n_2 \sin\theta_2$ $\frac{n_1}{n_2} = \frac{v_2}{v_1}$ ***Diffraction:*** *(spread out)* $\Delta L = d \sin\theta$ Double-slit Maxima: $d \sin\theta = m\lambda$ $m = 0, \pm1, \pm2, \ldots$
	$s = r\theta$				
	$x(t) = A\cos(\omega t + \phi)$ $x(t) = A\cos(2\pi f t + \phi)$ *Waves:* $f(x,t) = A\sin(2\pi\left(ft - \frac{x}{\lambda}\right) + \phi) + k$			*Optics*:  	

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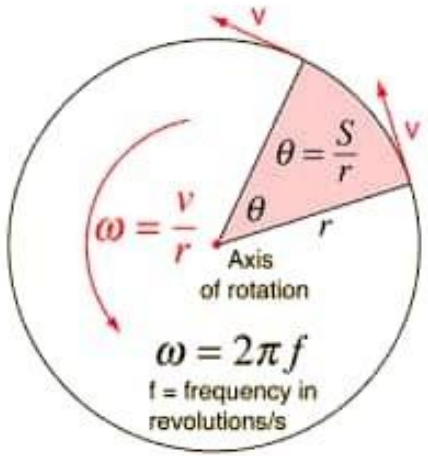
	Mechanics: Linear	Mechanics: Angular	Electricity / Magnetism	Fluid Mechanics / Thermodynamics	Atomic and Nuclear / Waves and Optics
Velocity (m/s) **Angular Velocity /** Angular Frequency (rad/s)	$v_{ave} = \frac{\Delta x}{\Delta t}$ $v = \frac{dx}{dt}$ $\Delta v = v_f - v_0$ *Constant linear acceleration:* $v = v_0 + at$ $v^2 = v_0^2 + 2a\Delta x$ $\bar{v} = \frac{v_0 + v}{2}$ *Variable linear acceleration:* $v(t) = v_0 + \int_{t_0}^{t} a\, dt$	$\omega_{ave} = \frac{\Delta\theta}{\Delta t}$ $\omega = \frac{d\theta}{dt}$ $\Delta\omega = \omega_f - \omega_0$ *Constant angular accel:* $\omega = \omega_0 + \alpha t$ $\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$ $\bar{\omega} = \frac{\omega_0 + \omega}{2}$ $\omega(t) = \omega_0 + \int_{t_0}^{t} \alpha\, dt$ $\omega = \frac{2\pi}{T} = 2\pi f$ $\omega_{spring} = \sqrt{\frac{k}{m}}$ $\omega_{pendulum} = \sqrt{\frac{g}{\ell}}$ *(for small $\Delta\theta$)*	*Speed of Light:* $c \approx 3.00 \times 10^8 \frac{m}{s}$ *Current Density:* $\boldsymbol{j} = nq\boldsymbol{u}$ *n = number density of charge carriers (m^{-3})* *q = charge of each carrier (C)* *u = drift velocity (m/s)*	*<u>Fluid Mechanics</u>:* *Continuity:* $A_1 v_1 = A_2 v_2$ $v_{rms} = \sqrt{\frac{3RT}{M}}$ $v_{rms} = \sqrt{\frac{3k_B T}{\mu}}$ *Torricelli's Law:* $v = \sqrt{2gh}$ *Speed of fluid exiting a hole in a tank.*	*<u>Waves and Optics</u>:* $v = f\lambda$ ***Reflection**:* *(return into the original medium)* *Critical angle:* $\sin\theta_c = \frac{n_2}{n_1}$ *for light traveling from medium 1 into medium 2, with $n_1 > n_2$.* ***Maxima for a thin film:*** *Constructive* $2d = \frac{\lambda}{2n}, 3\frac{\lambda}{2n}, 5\frac{\lambda}{2n} \ldots$ $= \left(m + \frac{1}{2}\right)\frac{\lambda}{n}$ *Destructive* $2d = \frac{m}{n}\lambda$ *Assumes normal incidence and one reflection phase reversal.*
	$v = \omega r$ $\boldsymbol{v} = \boldsymbol{\omega} \times \boldsymbol{r}$ $v(t) = -A\omega \sin(\omega t + \phi)$ $v(t) = -A(2\pi f) \sin(2\pi f t + \phi)$				

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	Mechanics: Linear	Mechanics: Angular	Electricity / Magnetism	Fluid Mechanics / Thermodynamics	Atomic and Nuclear / Waves and Optics

Acceleration (m/s^2) (rad/s^2)

Linear:

$$a_{ave} = \frac{\Delta v}{\Delta t}$$

$$a = \frac{dv}{dt}$$

$$a = \frac{\sum F}{m} = \frac{F_{net}}{m}$$

Tangential (linear):

$\boldsymbol{a} = \boldsymbol{a}_t$

(no normal acceleration)

Angular:

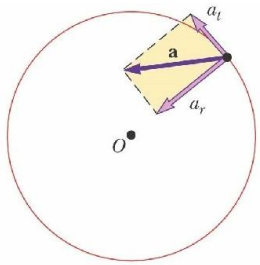
$$\alpha_{ave} = \frac{\Delta \omega}{\Delta t}$$

$$\alpha = \frac{d\omega}{dt}$$

$$\alpha = \frac{\sum \tau}{I} = \frac{\tau_{net}}{I}$$

Centripetal (center):

$$a_c = a_n = \frac{v^2}{r} = \omega^2 r$$



Fixed-radius circular motion:

$$a_r = -\frac{v^2}{r}$$

General motion:

$$a_n = \frac{v^2}{\rho}$$

$$a^2 = a_t^2 + a_r^2$$

$a_r = -a_c$ radial/centripetal
$a_t = a_\theta$ tangential/transverse

Polar Coord.:

$$a_r = \ddot{r} - r\dot{\theta}^2$$

$$a_t = r\ddot{\theta} + 2\dot{r}\dot{\theta}$$

$$a_t = \alpha r$$

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

Jerk (Jolt) (m/s^3) (rad/s^3)

$$\vec{\boldsymbol{j}}_{ave} = \frac{\Delta \boldsymbol{a}}{\Delta \boldsymbol{t}}, \quad \vec{j} = \frac{da}{dt}$$

$$\boldsymbol{\zeta}_{ave} = \frac{\Delta \boldsymbol{\alpha}}{\Delta \boldsymbol{t}}, \zeta = \frac{d\alpha}{dt}$$

Physical Constants (2022 CODATA):

Gravitational Constant	$G \approx 6.674\,30(15) \times 10^{-11}\ \frac{m^3}{kg\,s^2}$
Std. Acceleration Gravity	$g_n = 9.806\,65\ \frac{m}{s^2} \approx 32.174\,0\ \frac{ft}{s^2}$, $(g \approx g_n)$
Speed of Light in Vacuum	$c = 2.997\,924\,58 \times 10^8\ \frac{m}{s}$
Electron-Volt	$1eV = 1.602\,176\,634 \times 10^{-19}\ J$
Elementary Charge	$e = 1.602\,176\,634 \times 10^{-19}\ C,\ (q_e = -e)$
Mass of an Electron	$m_e \approx 9.109\,383\,713\,9(28) \times 10^{-31}\ kg$
Mass of a Proton	$m_p \approx 1.672\,621\,925\,95(52) \times 10^{-27}\ kg$
Mass of a Neutron	$m_n \approx 1.674\,927\,498\,04(95) \times 10^{-27}\ kg$
Electric Permittivity	$\varepsilon_0 = \frac{1}{\mu_0 c^2} \approx 8.854\,187\,818\,8(14) \times 10^{-12}\ \frac{C^2}{Nm^2}$
Magnetic Permeability	$\mu_0 \approx 1.256\,637\,061\,27(20) \times 10^{-6}\ \frac{N}{A^2}$
Boltzmann Constant	$k_B = 1.380\,649 \times 10^{-23}\ \frac{J}{K}$
Coulomb Constant	$k_e = \frac{1}{4\pi\varepsilon_0} \approx 8.987\,551\,792\,3 \times 10^9\ \frac{Nm^2}{C^2}$
Faraday Constant	$F = eN_A \approx 9.648\,533\,212 \times 10^4\ \frac{C}{mol}$
Planck Constant	$h = 6.626\,070\,15 \times 10^{-34}\ Js$
Avogadro Constant	$N_A = 6.022\,140\,76 \times 10^{23}\ /\ mole$
Ideal Gas Constant	$R \approx 0.082\,057\,366\,080\ \frac{L\,atm}{mole\,K}$
"	$R \approx 8.314\,462\,618\ \frac{J}{mole\,K}$
pi	$\pi \approx 3.141\,592\,653\,589\,793\,238\,462\ldots$

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	Mechanics: Linear	Mechanics: Angular	Electricity / Magnetism	Fluid Mechanics / Thermodynamics	Atomic and Nuclear / Waves and Optics
Dynamics	See Harold's Physics Forces with FBD Cheat Sheet See Harold's Physics Atwood Machine Cheat Sheet		See Harold's Physics Forces on an Incline Cheat Sheet See Harold's Physics Forces on an Incline with Pulley Cheat Sheet		
Mass (kg) / Moment of Inertia ($\text{kg} \bullet \text{m}^2$)	m = actual mass I = rotational analog of mass Inertia is an object's resistance to changes in its angular velocity.	$I = \sum mr^2$ $I = \int r^2 \, dm$ $I = \int \boldsymbol{r}_\perp \bullet \boldsymbol{r} \, dm$ *(r = perp. distance from the rotation axis.)*	$m_p \approx m_n$ $m_p \approx 1{,}836 \, m_e$	*Density:* $\rho = \frac{m}{V}$ $\rho_{H_2O} = 1000 \, \frac{kg}{m^3}$	*Magnification:* $\lvert M \rvert = \left\lvert \frac{d_i}{d_o} \right\rvert = \left\lvert \frac{h_i}{h_o} \right\rvert$ $M_{Telescope} = -\frac{f_{objective\ lens}}{f_{eyepiece}}$
Force (N = kg•m/s^2) / Torque (N•m)	$F = ma$ $F_g = mg$ $\sum \boldsymbol{F} = \boldsymbol{F}_{net} = m\boldsymbol{a}$ $\sum F_x = ma_x$ $\sum F_y = ma_y$	$\tau = I\alpha$ (Fixed-axis rotation with constant I.) $\tau = rF \sin\theta = rF_\perp$ $\boldsymbol{\tau} = \boldsymbol{r} \times \boldsymbol{F}$ $\sum \boldsymbol{\tau} = \boldsymbol{\tau}_{net} = I\boldsymbol{\alpha}$	*Electricity:* *Coulomb's Law:* $\boldsymbol{F} = k \frac{q_1 \, q_2}{r^2} \hat{\mathbf{r}}$ $F = \frac{1}{4\pi\epsilon_0} \frac{q_1 \, q_2}{r^2}$ $\boldsymbol{F} = \boldsymbol{E}q$	*Fluid Mechanics:* $P = \frac{F}{A}$ $\Delta P = \rho h g$ $F_{buoy} = \rho V g$ *Universal Gas Law:* $PV = nRT = Nk_BT$	*Strong Nuclear Force:* $F_r(r) = -Ae^{\frac{-r}{\lambda}}\left(\frac{1}{r^2} + \frac{1}{\lambda r}\right)$ *(Yukawa model)* *Weak Nuclear Force:* $n \rightarrow p^+ + e^- + \overline{ve}$ *(Beta Decay)* *where $\overline{ve}$ is an antineutrino*

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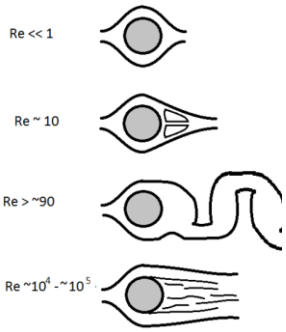
	$\sum F_z = ma_z$ $F_{net,ave} = \frac{\Delta p}{\Delta t}$ $F = \frac{dp}{dt} = \frac{d}{dt}(mv)$ Friction: $F_{\mu_s} \leq \mu_s N$ $F_{\mu_k} = \mu_k N$ $0 \leq \mu_k \leq \mu_s$ *Gravitational Force:* $F_G = G\frac{m_1 m_2}{r^2}$ $\boldsymbol{F}_G = -G\frac{m_1 m_2}{r^2}\hat{\boldsymbol{r}}$	$\tau_{net,ave} = \frac{\Delta L}{\Delta t}$ $\tau = \frac{dL}{dt} = I\frac{d\omega}{dt}$ $F = ma_c$ $F = \frac{mv^2}{r} = mr\omega^2$ *(net inward force)* *Hooke's Law:* $\boldsymbol{F}_s = -k\Delta\boldsymbol{x}$	*Magnetism:* $F_B = \lvert qvB\sin\theta\rvert$ $F_B = BI\ell\sin\theta$ $\boldsymbol{F}_B = q\boldsymbol{v}\times\boldsymbol{B}$ $\boldsymbol{F}_B = I\boldsymbol{\ell}\times\boldsymbol{B}$ $\boldsymbol{F} = \int I\, d\boldsymbol{\ell}\times\boldsymbol{B}$	*Reynolds Number:* $Re = \frac{uL}{\nu} = \frac{\rho uL}{\mu}$ • Low Re → laminar (sheet-like) flow • High Re → turbulent flow (cavitation if local pressure is low)	
Yank (N/s) / Rotatum (N•m/s) *(torque jerk)*	$Y = mj = m\frac{da}{dt}$ *(constant mass)* $Y_{ave} = \frac{\Delta F}{\Delta t}, Y = \frac{dF}{dt}$	$R = I\zeta = I\frac{d\alpha}{dt}$ *(fixed-axis rotation with constant I)*	$R_{ave} = \frac{\Delta\tau}{\Delta t}$ $R = \frac{d\tau}{dt}$	$\boldsymbol{R} = \boldsymbol{r}\times\boldsymbol{Y}$ *(fixed r)* $\boldsymbol{R} = (\boldsymbol{v}\times\boldsymbol{F}) + (\boldsymbol{r}\times\boldsymbol{Y})$ *(fixed origin)*	

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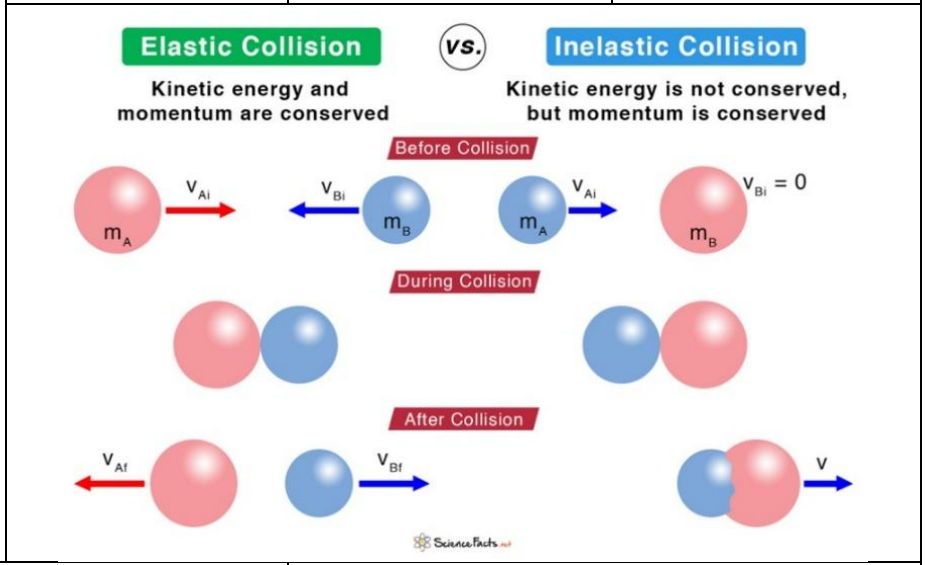
	Mechanics: Linear	Mechanics: Angular	Electricity / Magnetism	Fluid Mechanics / Thermodynamics	Atomic and Nuclear / Waves and Optics
Impulse and Momentum					
Momentum (kg•m/s) (kg • m^2/s)	$\boldsymbol{p} = m\boldsymbol{v}$ $\Delta\boldsymbol{p} = m\Delta\boldsymbol{v}$ *(constant m)* *Conservation of Linear Momentum:* $\boldsymbol{p}_i = \boldsymbol{p}_f$ $\sum m\boldsymbol{v}_i = \sum m\boldsymbol{v}_f$ $\boldsymbol{p} = m(\boldsymbol{\omega} \times \boldsymbol{r})$ *Linear Impulse and Momentum:* $\sum m_i(v_i)_1 +$ $\sum \int_{t_1}^{t_2} F\, dt = \sum m_i(v_i)_2$	$L = rmv\ sin\ \theta$ $\Delta\boldsymbol{L} = I\Delta\boldsymbol{\omega}$ *(fixed-axis rotation, constant I)* *Conservation of Angular Momentum:* $\boldsymbol{L}_i = \boldsymbol{L}_f$ $\sum I\boldsymbol{\omega}_i = \sum I\boldsymbol{\omega}_f$ $\boldsymbol{L} = \boldsymbol{r} \times \boldsymbol{p}$ $\boldsymbol{L} = \boldsymbol{r} \times (m\boldsymbol{v})$ $L = \int \boldsymbol{r} \times \boldsymbol{v}\ dm$ $\Delta L = \int \tau\ dt$	*Radius of Curvature* $\rho = \left\lvert \frac{(1 + y'^2)^{\frac{3}{2}}}{y''} \right\rvert$	*Fluid Mechanics:* $\nabla p = \rho g$ $\frac{dp}{dy} = -\rho g$ $F = \rho V g$	*Atomic and Nuclear:* $\lambda = \frac{h}{p}$
					
Impulse (N•s) (N•m•s)	*Constant net force:* $I = F\,\Delta t = \Delta p = m\Delta v$ *(constant m)* $\sum \int_{t_1}^{t_2} F\, dt = F_{net}(t_2 - t_1)$ Variable net force: $I = \sum \int_{t_1}^{t_2} F\, dt = \Delta p$	*Constant net torque:* $H = \Delta L = \tau\,\Delta t = I\Delta\omega$ *(fixed-axis rotation, constant I)* $H = \Delta L = \sum \int_{t_1}^{t_2} \tau\, dt = \tau_{net}(t_2 - t_1)$ *Variable net torque:* $\boldsymbol{H} = \Delta\boldsymbol{L} = \int_{t_1}^{t_2} \boldsymbol{\tau_{net}}\, d\boldsymbol{t} = \int_{t_1}^{t_2} (\boldsymbol{r} \times \boldsymbol{F})\, dt$		*Elastic Collision:* $m_A(v_A)_1 + m_B(v_B)_1 = m_A(v_A)_2 + m_B(v_B)_2$ $K_{A1} + K_{B1} = K_{A2} + K_{B2}$ *Perfectly Inelastic Collision:* $m_A(v_A)_1 + m_B(v_B)_1 = (m_A + m_B)v_2$	

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	Mechanics: Linear	Mechanics: Angular	Electricity / Magnetism	Fluid Mechanics / Thermodynamics	Atomic and Nuclear / Waves and Optics
Energy					
Work (J = N•m)	*Constant force:* $W = F_{\parallel} s = Fs\cos\theta$ $W = \boldsymbol{F} \bullet \boldsymbol{s}$ *Variable force:* $W = \int \boldsymbol{F} \bullet d\boldsymbol{s}$ $W = \int \boldsymbol{F} \bullet \boldsymbol{v}\, dt$	*Constant torque:* $W = \tau\, \Delta\theta$ *(fixed axis; $\Delta\theta$ in radians)* *Variable torque:* $W = \int \tau_{axis}\, d\theta$ $W = \int \boldsymbol{\tau} \bullet \boldsymbol{\omega}\, dt$	$W = QV_{drop}$ $W_{\text{electric}} = -q\Delta V$	*Thermodynamics:* *Constant pressure:* $W = P\, \Delta V$ $W = \int P\, dV$ $e = \left\lvert \frac{W}{Q_H} \right\rvert$ $e_c = \frac{T_H - T_C}{T_H}$	** Needs steady, incompressible, inviscid flow along a streamline, with no pump/turbine work* *** Closed system; negligible changes in macroscopic kinetic and potential energy.*
Kinetic Energy (J)	*Translational:* $K = KE = \frac{1}{2}mv^2$	*Rotational:* $K = KE = \frac{1}{2}I\omega^2$	$1\ eV \approx 1.60 \times 10^{-19}\ J$	*Fluid Mechanics:* *Bernoulli's Equation*:* $P_1 + \rho g y_1 + \frac{1}{2}\rho {v_1}^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho {v_2}^2$	
	Work-Energy Theorem: $W_{net} = \Delta K = K_f - K_i = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$			*Thermodynamics:* $K_{avg} = \frac{3}{2}k_B T$	*Atomic and Nuclear:* $K_{max} = hf - \phi$
Potential Energy (J)	$\Delta U_g = mg\Delta h$ $PE = U_g = mgh$ $U_G = -G\frac{m_1 m_2}{r}$ $G \approx 6.67 \times 10^{-11}\ \frac{Nm^2}{kg^2}$	*Coiled Spring:* $U_s = \frac{1}{2}k\Delta x^2$ *Mechanical Energy:* $ME = KE + PE$ *Conservation of Mechanical Energy:* $K_1 + U_1 = K_2 + U_2$ *where* $U = U_g\ and/or\ U_s$ *(Zero nonconservative work)*	*Point charges:* $U_E = qV$ $U_E = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r}$ *Capacitor/inductor:* $U_C = \frac{1}{2}QV = \frac{1}{2}CV^2$ $U_L = \frac{1}{2}LI^2$	*Fluid Mechanics:* $P = P_0 + \rho g h$ *Continuity of Mass:* $\rho_1 A_1 v_1 = \rho_2 A_2 v_2$ *Continuity of Volume:* $A_1 v_1 = A_2 v_2$ *Thermodynamics 1st Law**:* $\Delta U_{internal} = Q - W_{by}$	*Atomic and Nuclear:* $E = hf$ $E_0 = mc^2$ $\Delta E = (\Delta m)c^2$ *Relativity:* $E = mc^2\left(\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}\right)$

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<table>
<tr><th></th><th>Mechanics: Linear</th><th>Mechanics: Angular</th><th>Electricity / Magnetism</th><th>Fluid Mechanics / Thermodynamics</th><th>Atomic and Nuclear / Waves and Optics</th></tr>
<tr><td>Heat Energy (J)</td><td colspan="2">Energy transferred by heating is Q.

Closed-system energy balance:
$Q > 0$ into the system
$W_{by} > 0$ for work done by it</td><td></td><td><u>Thermodynamics</u>:
$H = \frac{Q}{\Delta t} = \frac{kA\Delta T}{L}$
(steady heat conduction)
$Q = mH_f$
$Q = mH_v$</td><td>Hydrogen Electron Energy Levels:
$E_n = \frac{-13.6\ eV}{n^2}$
n = principal quantum number (1, 2, 3, etc.)</td></tr>
<tr><td>Energy (J)</td><td colspan="3">Conservation of Energy for an isolated system:
$E_{total} = E_i = E_f$

$E_{total} = \sum E_i = \sum E_f$

$E_{total} = K + U_{potential} + U_{internal}$

Closed-system energy balance:
$\Delta E_{\text{total}} = \Delta K + \Delta U_{potential} + \Delta U_{internal} = Q - W_{by}$</td><td colspan="2">$\Delta E = Q = mC\Delta T = mC(T_f - T_i)$
(Heat is the only energy transfer, no phase change, and approximately constant specific heat)

$T_f = \frac{m_1C_1T_{1i} + m_2C_2T_{2i}}{m_1C_1 + m_2C_2}$
(No heat exchange with surroundings, no phase change, negligible calorimeter heat capacity, constant specific heats)
$C_{H_2O} = 4{,}184\ \frac{J}{kg \cdot K}$</td></tr>
<tr><td rowspan="2">Power (W)</td><td colspan="2">$P_{ave} = \frac{W}{\Delta t}$</td><td rowspan="2">$P = IV$

$P = I^2R$

$P = \frac{V^2}{R}$</td><td rowspan="2">$P = \Delta p\ Q$

Where:
$p = pressure\ \left(\frac{N}{m^2}\right)$

$Q = volumetric\ flow\ rate\ \left(\frac{m^3}{s}\right)$</td><td rowspan="2"></td></tr>
<tr><td>$P = F_{\parallel}v$

Energy transferred by the process:
$P_{ave} = \frac{\Delta E}{\Delta t}$

$P = \frac{dE}{dt}$

$P = Fv\cos\theta$

$P = \boldsymbol{F} \bullet \boldsymbol{v}$</td><td>$P = \tau_{\parallel}\omega$

Energy transferred by the process:
$P_{ave} = \frac{\Delta W}{\Delta t}$

$P = \frac{dW}{dt}$

$P = \tau\omega\cos\phi$

$P = \boldsymbol{\tau} \bullet \boldsymbol{\omega}$</td></tr>
</table>

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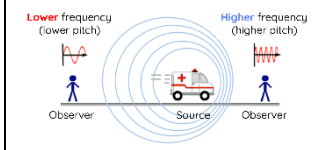
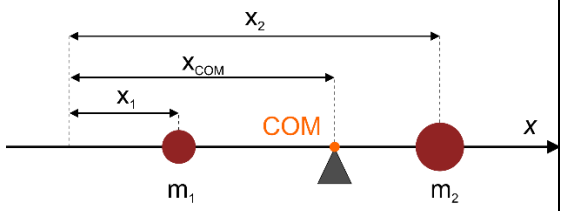
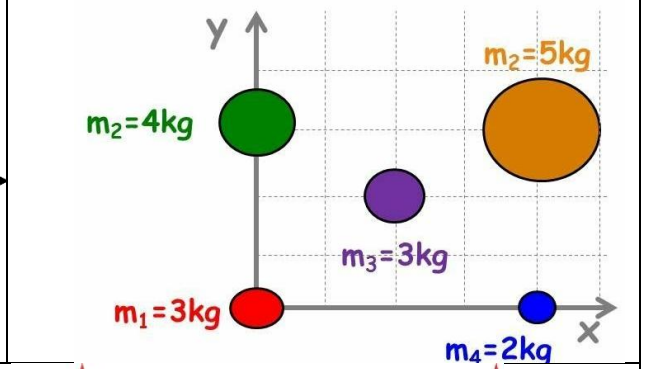
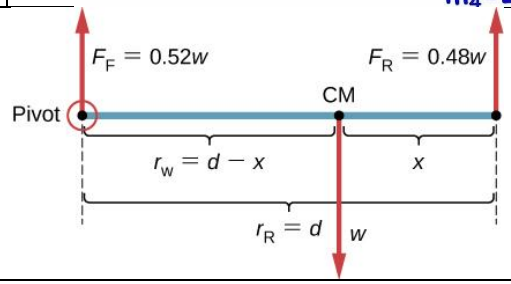
	Mechanics: Linear	Mechanics: Angular	Electricity / Magnetism	Fluid Mechanics / Thermodynamics	Atomic and Nuclear / Waves and Optics
Engineering Application		See Harold's Center of Mass / Moment of Inertia Cheat Sheet See Harold's Physics Doppler Effect Cheat Sheet			
Period (s) / Frequency (Hz)	$T = \frac{1}{f}$ $f = \frac{1}{T}$ *Kepler's Third Law:* $T^2 = \left(\frac{4\pi^2}{GM}\right) r^3$ *(M dominant; r is circular-orbit radius)*	$T = \frac{1}{f} = \frac{2\pi}{\omega} = \frac{2\pi r}{v}$ $T_{spring} = 2\pi\sqrt{\frac{m}{k}}$ $T_{pendulum} = 2\pi\sqrt{\frac{\ell}{g}}$ *(small oscillations)*	$T_{angular} = \frac{2\pi}{b}$ *For:* $y = sin(b\theta)$ $y = cos(b\theta)$	 ** = Receiver toward source: numerator +; source toward receiver: denominator −, with speeds measured relative to the medium.*	*Waves and Optics:* $f = \frac{v}{\lambda}$ *Doppler Effect:* $f_r = f_s\left(\frac{v \pm v_r}{v \mp v_s}\right)^*$
Center of Mass (m)	$x_{CM} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$ $r_{CM} = \frac{\sum mr}{\sum m}$ $\bar{x} = \frac{1}{M}\int_0^M x\, dm$ *where* $M = \int_0^M dm$ *and* $dm = \rho\, dz\, dy\, dx$			$x_{CM} = \frac{\sum m_i x_i}{\sum m_i}$ 	$y_{CM} = \frac{\sum m_i y_i}{\sum m_i}$
Rigid Bodies (Statics)	$\sum F_x = 0$ *(Right = '+')* $\sum F_y = 0$ *(Down = '−')*	$\sum \tau = 0$ *(CW = '−')* $\sum \tau = \sum\left(F_{y,i}\, x_i - F_{x,i}\, y_i\right) = 0$			

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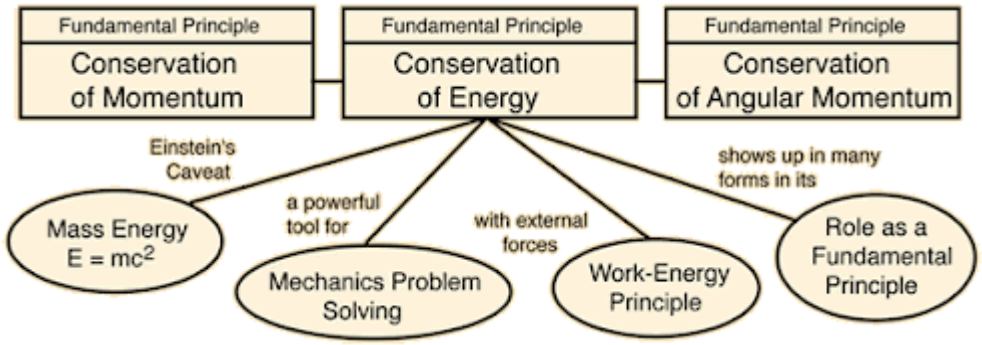
	Mechanics: Linear	Mechanics: Angular	Electricity / Magnetism	Fluid Mechanics / Thermodynamics	Atomic and Nuclear / Waves and Optics
Conservation Laws					
Fundamental Principle	*Conservation of Linear Momentum*	*Conservation of Angular Momentum*	*Conservation of Electric Charge*	*Conservation of Mass (or Matter)*	*Conservation of Energy*
Discipline	*Physics*	*Physics*	*Chemistry & Circuits*	*Chemistry & Fluid Mechanics*	*Physics*
Formula	$\sum \boldsymbol{p}_i = \sum \boldsymbol{p}_f$ $\sum m\boldsymbol{v}_i = \sum m\boldsymbol{v}_f$	$\sum \boldsymbol{L}_i = \sum \boldsymbol{L}_f$ $\sum I\boldsymbol{\omega}_i = \sum I\boldsymbol{\omega}_f$	$\sum Q_i = \sum Q_f$	$\sum m_i = \sum m_f$	$\sum E_i = \sum E_f$
Example	*Zero net external impulse for linear momentum. Zero net external angular impulse about the chosen origin for angular momentum.*		*Kirchhoff's Current Law (KCL):* $\sum_{i=1}^{n} I_i = 0$	*Continuity of Mass:* $\rho_1 A_1 v_1 = \rho_2 A_2 v_2$ *(Classical mass conservation, since mass alone is not conserved in nuclear reactions.)*	$\sum E_i = constant$ $\Delta E_{\text{total}} = \Delta K + \Delta U_{potential} + \Delta U_{internal} = Q - W_{by}$ *For an isolated system:* $E_{total} = K + U_{potential} + U_{internal} = constant$
					

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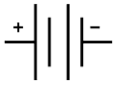
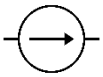
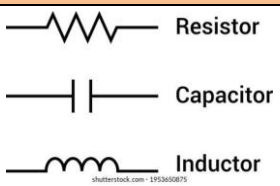
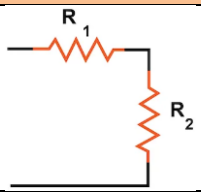
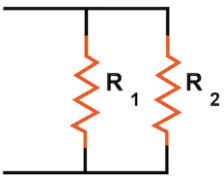
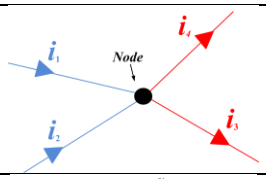
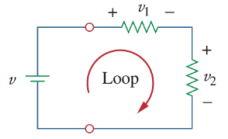
Electricity

Terms	Formulas	See Harold's Electromagnetic Spectrum Cheat Sheet See Harold's DC Circuits Cheat Sheet	
Electric Field (V/m or N/C)	$\boldsymbol{E} = \frac{\boldsymbol{F}}{q}$ $E_{x,avg} = -\frac{\Delta V}{\Delta x}$ $\boldsymbol{E} = \rho \boldsymbol{J}$	$E_r = -\frac{dV}{dr}$ *Electrostatic:* $\boldsymbol{E} = -\nabla V$	*Gauss's Law:* $\phi = \oint \boldsymbol{E} \bullet d\boldsymbol{A} = \frac{Q_{enc}}{\epsilon_0}$
Potential / Voltage (V)	$V = IR$ $V = \frac{Q}{C}$	$V = k\sum_i \frac{q_i}{r_i}$ $V = \frac{1}{4\pi\epsilon_0}\sum_i \frac{q_i}{r_i}$	
Current (A)	$I_{ave} = \frac{\Delta Q}{\Delta t}$ $I = \frac{V}{R}$	$I = \frac{dQ}{dt}$ $I = n\lvert e\rvert v_d A$	
Circuits		**Series**	**Parallel**
Circuit Terms			
Resistance (Ω)	$R = \frac{V}{I}$ $R = \frac{\rho \ell}{A}$	$R_s = \sum_i R_i$	$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$ $R_p = \frac{R_1 R_2}{R_1 + R_2}$
Inductance (H)	$L = N\frac{\Phi}{I}$ $L = \frac{V_L}{dI/dt}$ $L = \mu_0 \frac{N^2 A}{\ell}$	$L_s = \sum_i L_i$	$\frac{1}{L_p} = \sum_i \frac{1}{L_i}$
		L_s *and* L_p *assume negligible mutual inductance.*	
Capacitance (F)	$C = \frac{Q}{V}$ $C = \frac{\kappa \epsilon_0 A}{d}$	$\frac{1}{C_s} = \sum_i \frac{1}{C_i}$	$C_p = \sum_i C_i$
Kirchhoff's Current Law (KCL)	$\sum_{i=1}^{n} I_i = 0$ *The algebraic sum of currents in a network of conductors meeting at a* ***point*** *(node) is zero.*		
Kirchhoff's Voltage Law (KVL)	$\sum_{i=1}^{n} V_i = 0$ *The directed sum of the potential differences (voltages) around any closed* ***loop*** *is zero.*		 *KVL:* $-v + v_1 + v_2 = 0$

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Magnetism		
	See Harold's Physics Maxwell's Equations Cheat Sheet	
Term	**Formulas**	**Laws**
Magnetic Field (T)	$B = \frac{\mu_0}{2\pi}\frac{I}{r}$ $Solenoid$: $B_s = \mu_0 nI$ $where\ n = \frac{N}{\boldsymbol{\ell}}\ turns\ per\ meter$ *Moving-charge magnetic-field:* $\boldsymbol{B} = \frac{\mu_0}{4\pi}\frac{\lvert q\rvert \boldsymbol{v}\times\boldsymbol{r}}{r^3}$ $\boldsymbol{B} = \frac{\mu_0}{4\pi}\frac{\lvert q\rvert \boldsymbol{v}\times\hat{\boldsymbol{r}}}{r^2}$	*Ampere's Circuit Law:* $\oint \boldsymbol{B}\bullet d\boldsymbol{\ell} = \mu_o I + \mu_0\varepsilon_0\frac{d\Phi_E}{dt}$ *Gauss's Law:* $\oint \boldsymbol{B}\bullet d\boldsymbol{A} = 0$ $d\boldsymbol{B} = \frac{\mu_0}{4\pi}\frac{I\,d\boldsymbol{\ell}\times\boldsymbol{r}}{r^3}$
Magnetic Flux (Wb)	$\phi_B = BA\cos\theta$ $\phi_B = \boldsymbol{B}\bullet\boldsymbol{A}$	*Magnetic Flux:* $\Phi_B = \int \boldsymbol{B}\bullet d\boldsymbol{A}$
EMF (V)	$\varepsilon_{avg} = -\frac{\Delta\Phi_B}{\Delta t}$ $\varepsilon = \oint \boldsymbol{E}\bullet d\boldsymbol{s} = -\frac{d\Phi_B}{dt}$ *(single turn, stationary loop)* $\varepsilon = Blv$ *(magnitude; perpendicular rod, velocity, and uniform magnetic field)*	*Faraday's Law of Induction:* $\oint \boldsymbol{E}\bullet d\boldsymbol{\ell} = -\frac{d\Phi_B}{dt}$ $\varepsilon = -L\frac{dI}{dt}$

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