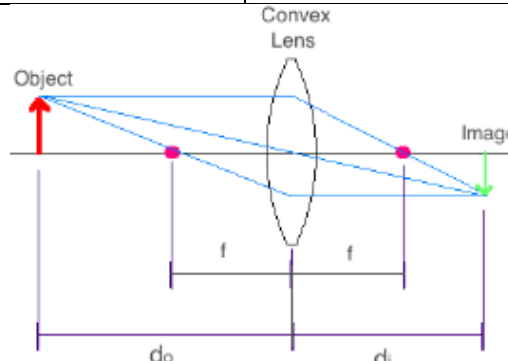
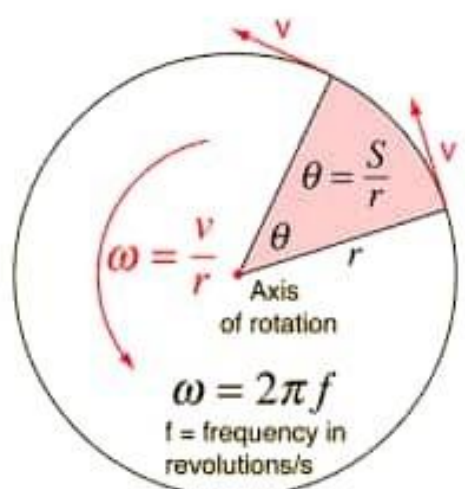


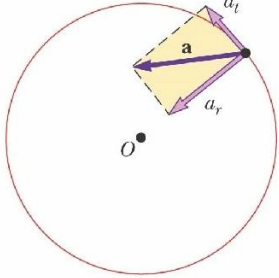
Harold's Physics Formulas – Calculus

Cheat Sheet

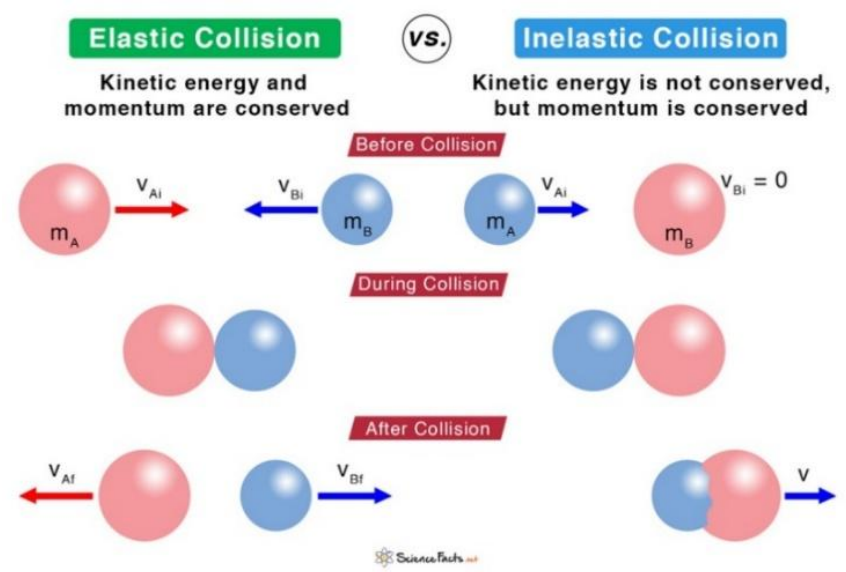
30 October 2026

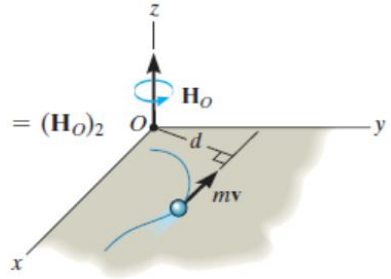
	Mechanics: Linear Translation	Mechanics: Angular / Rotational Motion	Electricity / Magnetism	Fluid Mechanics / Thermodynamics	Atomic and Nuclear / Waves and Optics
Kinematics	Bold = Vector	See Harold's Physics Units of Measure Cheat Sheet See Harold's Physics of Projectiles Cheat Sheet		See Harold's Physics Optics Cheat Sheet See Math and Greek Symbols	
Position (m) (rad)	<i>Constant linear acceleration:</i> $s = s_0 + v_0 t + \frac{1}{2} a t^2$ $x = x_0 + (v_0)_x t$ <i>(constant v)</i> $y = y_0 + v_{0y} t - \frac{1}{2} g t^2$ <i>(up is +, constant g, neglect air resistance)</i>	<i>Constant angular acceleration:</i> $\theta = \theta_0 + \omega_0 t + \frac{1}{2} a t^2$	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-	<i>Fluid Mechanics:</i> $\Delta \ell = \alpha \ell_0 \Delta T$	<i>Optics:</i> $f = \frac{v}{\lambda}$
				<i>Refraction: (bend)</i> $n = \frac{c}{v}$	$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$
				<i>Diffraction (spread):</i> $\Delta L = d \sin \theta$	
	<i>Variable linear acceleration:</i> $s(t) = s_0 + \int_{t_0}^t v dt$	<i>Variable angular acceleration:</i> $\theta(t) = \theta_0 + \int_{t_0}^t \omega dt$		Double-slit Maxima: $d \sin \theta = m \lambda$ $m = 0, \pm 1, \pm 2, \dots$	<i>Snell's Law:</i> $n_1 \sin \theta_1 = n_2 \sin \theta_2$ $\frac{n_1}{n_2} = \frac{v_2}{v_1}$
	$s = r \theta$ $x(t) = A \cos(\omega t + \phi)$ <i>Waves:</i> $f(x, t) = A \sin\left(2\pi\left(ft - \frac{x}{\lambda}\right) + \phi\right) + k$				

	Mechanics: Linear Translation	Mechanics: Angular / Rotational	Electricity / Magnetism	Fluid Mechanics / Thermodynamics	Atomic and Nuclear / Waves and Optics
Velocity (m/s) Angular Velocity / Angular Frequency (rad/s)	$v = \frac{ds}{dt}$ Constant linear acceleration: $v = v_0 + at$ $v = v_0 + \dot{v}t$ $v^2 = v_0^2 + 2a\Delta s$ Variable linear acceleration: $v(t) = v_0 + \int_{t_0}^t a \, dt$ $a \, ds = v \, dv$ $v_{ave} = \frac{\Delta s}{\Delta t}$	$\omega = \frac{d\theta}{dt}$ Constant angular acceleration: $\omega = \omega_0 + \alpha t$ $\omega = \omega_0 + \dot{\omega}t$ $\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$ Variable angular acceleration: $\omega(t) = \omega_0 + \int_{t_0}^t \alpha \, dt$ $\omega = \frac{2\pi}{T} = 2\pi f$ $\omega_{spring} = \sqrt{\frac{k}{m}}$ $\omega_{pendulum} = \sqrt{\frac{g}{\ell}}$ (for small $\Delta\theta$)	<p>Speed of Light: $c \approx 3.00 \times 10^8 \frac{m}{s}$</p> <p>Current Density: $\mathbf{j} = nq\mathbf{u}$</p> <p>$n$ = number density of charge carriers (m^{-3})</p> <p>q = charge of each carrier (C)</p> <p>u = drift velocity (m/s)</p>	<p>Fluid Mechanics:</p> <p>Continuity: $A_1v_1 = A_2v_2$ (steady, incompressible flow)</p> $v_{rms} = \sqrt{\frac{3RT}{M}}$ $v_{rms} = \sqrt{\frac{3k_B T}{\mu}}$ <p>Torricelli's Law: $v = \sqrt{2gh}$ (speed of fluid exiting a small outlet in a lg tank.)</p>	<p><u>Waves and Optics:</u> $v = f\lambda$</p> <p>Reflection: (return into the original medium)</p> <p>Critical angle: $\sin \theta_c = \frac{n_2}{n_1}$ For light traveling from medium 1 to medium 2, with $n_1 > n_2$.</p> <p>Maxima for a thin film: Constructive $2d = \frac{\lambda}{2n}, 3\frac{\lambda}{2n}, 5\frac{\lambda}{2n} \dots$ $= \left(m + \frac{1}{2}\right)\frac{\lambda}{n}$ (λ = vacuum wavelen.)</p> <p>Destructive $2d = \frac{m}{n}\lambda$</p> <p>Assumes normal incidence and one reflection phase reversal.</p>
	$\mathbf{v} = \boldsymbol{\omega} \times \mathbf{r}$ $v(t) = -A\omega \sin(\omega t + \phi)$				
	Polar Coordinates: $v_r = \dot{r}$ $v_\theta = r\dot{\theta}$				

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Acceleration (m/s²) (rad/s²)	<u>Linear:</u> $a = \frac{dv}{dt} = \dot{v}$ $a = \frac{\sum F}{m} = \frac{F_{net}}{m}$ <u>Straight-line motion:</u> $\mathbf{a} = \mathbf{a}_t$ (no normal acceleration)	<u>Angular:</u> $\alpha = \frac{d\omega}{dt}$ $\alpha d\theta = \omega d\omega$ $\alpha = \frac{\sum \tau}{I} = \frac{\tau_{net}}{I}$ <u>Centripetal (center):</u> $a_c = a_n = \frac{v^2}{r} = \omega^2 r$	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 $\epsilon_0 = \frac{1}{\mu_0 c^2} \approx 8.854\,187\,818\,8(14) \times 10^{-12} \frac{C^2}{Nm^2}$ 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 $k_e = \frac{1}{4\pi\epsilon_0} \approx 8.987\,551\,792\,3 \times 10^9 \frac{Nm^2}{C^2}$ 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 $\pi \approx 3.141\,592\,653\,589\,793\,238\,462 \dots$		
		Fixed-radius circular motion: $a_r = -\frac{v^2}{r}$ General motion: $a_n = \frac{v^2}{\rho}$			
	$\mathbf{a} = \mathbf{a}_t + \mathbf{a}_r$ $a_r = -a_c = -a_n$ (radial/centripetal) $a_t = a_\theta$ (tangential/transverse)	General polar motion coordinates: $a_r = \ddot{r} - r\dot{\theta}^2$ $a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta}$			
	$a_t = \alpha r$ (fixed-radius circular motion) $\mathbf{a}_P = (\alpha \times \mathbf{r}) + (\omega \times (\omega \times \mathbf{r}))$ (rigid body rotating about a fixed point O) $a(t) = -A\omega^2 \cos(\omega t + \phi)$				
Jerk (Jolt) (m/s³) (rad/s³)	$j = \frac{da}{dt}$	$\zeta = \frac{d\alpha}{dt}$			

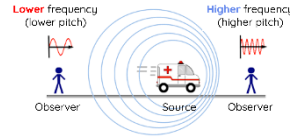
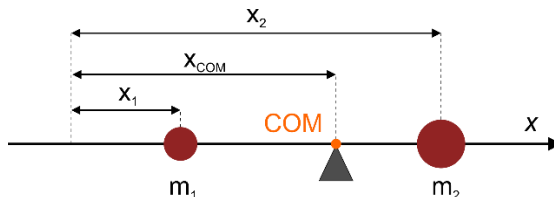
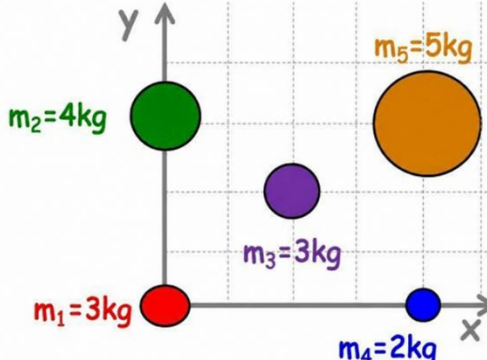
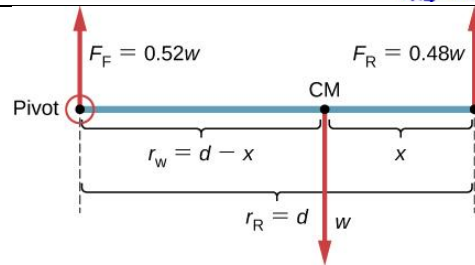
	Mechanics: Linear Translation	Mechanics: Angular / Rotational	Electricity / Magnetism	Fluid Mechanics / Thermodynamics	Atomic and Nuclear / Waves and Optics
Dynamics	See Harold's Physics Forces with FBD Cheat Sheet See Harold's Physics Atwood Machine Cheat Sheet		See Harold's Physics Forces on an Incline Cheat Sheet See Harold's Physics Forces on an Incline with Pulley Cheat Sheet		
Mass (kg) / Moment of Inertia (kg • m ²)	m = actual mass I = rotational analog of mass Inertia is an object's resistance to changes in its angular velocity.	$I = \sum mr^2$ $I = \int r^2 dm$ $I = \int \mathbf{r}_\perp \cdot \mathbf{r} dm$ (r = perp. distance from the rotation axis.)	$m_p \approx m_n$ $m_p \approx 1,836 m_e$	Mass Density: $\rho = \frac{m}{V}$ $\rho_{H_2O} = 1000 \frac{kg}{m^3}$	Magnification: $ M = \left \frac{d_i}{d_o} \right = \left \frac{h_i}{h_o} \right $ $M_{Telescope} = -\frac{f_{objective\ lens}}{f_{eyepiece}}$
Force (N = kg•m/s²) / Torque (N•m)	$F = ma$ $F_g = mg$ (constant mass) $\sum \mathbf{F} = \mathbf{F}_{net} = m\mathbf{a}$ (See the different coordinate systems on the bottom right.) $\sum \mathbf{F}_{ext} = \frac{d\mathbf{p}}{dt} = \frac{d(m\mathbf{v})}{dt}$ Friction: $F_{\mu_s} \leq \mu_s N$ $F_{\mu_k} = \mu_k N$ Typically $0 \leq \mu_k \leq \mu_s$ Gravitational Force: $\mathbf{F}_G = -G \frac{m_1 m_2}{r^2} \hat{\mathbf{r}}$	$\tau = I\alpha$ (fixed-axis rotation with constant I) $\boldsymbol{\tau} = \mathbf{r} \times \mathbf{F}$ $\sum \boldsymbol{\tau} = \boldsymbol{\tau}_{net} = I\alpha$ $\boldsymbol{\tau} = \frac{d\mathbf{L}}{dt} = I \frac{d\boldsymbol{\omega}}{dt}$ $F = ma_c$ $F = \frac{mv^2}{r} = mr\omega^2$ (net inward force) Hooke's Law: $\mathbf{F}_s = -k\Delta\mathbf{s}$	Electricity: Coulomb's Law: $\mathbf{F} = k \frac{q_1 q_2}{r^2} \hat{\mathbf{r}}$ $\mathbf{F} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2} \hat{\mathbf{r}}$ $\mathbf{F} = Eq$ Magnetism: $\mathbf{F}_B = q\mathbf{v} \times \mathbf{B}$ $\mathbf{F}_B = I\boldsymbol{\ell} \times \mathbf{B}$ $\mathbf{F} = \int I d\boldsymbol{\ell} \times \mathbf{B}$	Fluid Mechanics: $P = \frac{F}{A}$ $\Delta P = \rho hg$ $F_{buoy} = \rho Vg$ Universal Gas Law: $PV = nRT = Nk_B T$ (absolute P ; T in kelvins) Rectangular Coordinates: $\sum F_x = ma_x = m\ddot{x}$ $\sum F_y = ma_y = m\ddot{y}$ $\sum F_z = ma_z = m\ddot{z}$	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: $n \rightarrow p^+ + e^- + \bar{\nu}_e$ (Beta Decay) where $\bar{\nu}_e$ is an antineutrino Polar/Cylindrical Coordinates: $\sum F_r = m(\ddot{r} - r\dot{\theta}^2)$ $\sum F_\theta = m(r\ddot{\theta} + 2\dot{r}\dot{\theta})$ $\sum F_z = m\ddot{z}$

	Mechanics: Linear Translation	Mechanics: Angular / Rotational	Electricity / Magnetism	Fluid Mechanics / Thermodynamics	Atomic and Nuclear / Waves and Optics
Impulse and Momentum					
Momentum (kg•m/s) (kg • m ² /s)	Constant Mass: $\mathbf{p} = m\mathbf{v}$ $\Delta\mathbf{p} = m\Delta\mathbf{v}$ Conservation of Linear Momentum*: $\mathbf{p}_1 = \mathbf{p}_2$ $\sum m\mathbf{v}_1 = \sum m\mathbf{v}_2$ $\mathbf{p} = m(\boldsymbol{\omega} \times \mathbf{r})$	Constant Mass: $\mathbf{L} = \mathbf{r} \times \mathbf{p}$ $\mathbf{L} = \mathbf{r} \times (m\mathbf{v})$ Conservation of Angular Momentum*: $\mathbf{L}_1 = \mathbf{L}_2$ $\sum I\boldsymbol{\omega}_1 = \sum I\boldsymbol{\omega}_2$ $\mathbf{L} = \int \mathbf{r} \times \mathbf{v} \, dm$	Electromagnetic Field Momentum: $\mathbf{P}_{\text{field}} = \frac{1}{\mu_0 c^2} \int \mathbf{E} \times \mathbf{B} \, dV$ Eccentric Impact: $e = \frac{v_{B2} - v_{A2}}{v_{A1} - v_{B1}}$ (along the line of impact)	<u>Fluid Mechanics:</u> $\nabla P = \rho \mathbf{g}$ (hydrostatic equilibrium) $\frac{dP}{dy} = -\rho g$ Steady Fluid Streams: $\sum \mathbf{F} = \frac{dm}{dt}(\mathbf{v}_B - \mathbf{v}_A)$ $\sum \mathbf{M}_O = \frac{dm}{dt}((\mathbf{r}_B \times \mathbf{v}_B) - (\mathbf{r}_A \times \mathbf{v}_A))$	
	Linear Impulse and Momentum: $m_i(v_i)_1 + \sum \int_{t_1}^{t_2} \mathbf{F} \, dt = m_i(v_i)_2$	Angular Impulse and Momentum: $I_i(\omega_i)_1 + \sum \int_{t_1}^{t_2} \boldsymbol{\tau} \, dt = I_i(\omega_i)_2$			
	Elastic Collision: $m_A(v_A)_1 + m_B(v_B)_1 = m_A(v_A)_2 + m_B(v_B)_2$ $K_{A1} + K_{B1} = K_{A2} + K_{B2}$	$\Delta L = \int \boldsymbol{\tau} \, dt = I\Delta\boldsymbol{\omega}$ (fixed axis, constant I) Normal component of acceleration: $a_n = \frac{v^2}{\rho}$ (a_n is always directed in the +n direction.)			
	Perfectly Inelastic Collision: $m_A(v_A)_1 + m_B(v_B)_1 = (m_A + m_B)v_2$				
	Propulsion with Variable Mass: (- rocket, + shovel) $\sum F_{cv} = m \frac{dv}{dt} \pm v_{D/e} \frac{dm_e}{dt}$	Radius of Curvature: $\rho = \left \frac{(1 + y'^2)^{3/2}}{y''} \right $			
			* Zero net external impulse for linear momentum. Zero net external angular impulse about the chosen origin for angular momentum.		

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Impulse (N•s) (N•m•s)	<p><i>Constant net force:</i> $J = F \Delta t = \Delta p = m \Delta v$ <i>(constant m)</i></p> $J = \sum \int_{t_1}^{t_2} F dt$ $= F_{net}(t_2 - t_1)$ <p><i>Variable net force:</i> $J = \sum \int_{t_1}^{t_2} F dt = \Delta p$</p>	<p><i>Constant net torque:</i> $H = \Delta L = \tau \Delta t = I \Delta \omega$ <i>(fixed-axis rotation, constant I)</i></p> $\Delta L = \int_{t_1}^{t_2} \tau_{net,ext} dt = \tau_{net,ext}(t_2 - t_1)$ <p><i>Variable net torque:</i> $\Delta L = \int_{t_1}^{t_2} \tau_{net} dt$</p> $\Delta L = \int_{t_1}^{t_2} (\mathbf{r} \times \mathbf{F}) dt$ <i>(single external force; fixed origin)</i>	 <p><i>Angular Momentum</i></p>		
Yank (N/s) / Rotatum (N•m/s) <i>(torque jerk)</i>	$Y = mj = m \frac{da}{dt}$ <i>(constant mass)</i> $Y = \frac{dF}{dt} = m\ddot{x}$	$R = I\zeta = I \frac{d\alpha}{dt}$ <i>(fixed-axis rotation, constant I)</i> $R = \frac{d\tau}{dt} = I\ddot{\theta}$	$\mathbf{R} = \mathbf{r} \times \mathbf{Y}$ <i>(fixed r)</i> $\mathbf{R} = (\mathbf{v} \times \mathbf{F}) + (\mathbf{r} \times \mathbf{Y})$ <i>(fixed origin)</i>	<u>Atomic and Nuclear:</u> $\lambda = \frac{h}{p}$	

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Energy					
Work (J = N•m)	<p>Constant force: $W = \mathbf{F} \cdot \Delta \mathbf{s}$ ($\Delta \mathbf{s}$ is displacement)</p> <p>Variable force: $W = \int \mathbf{F} \cdot d\mathbf{s}$ $W = \int \mathbf{F} \cdot \mathbf{v} dt$</p>	<p>Constant torque: $W = \tau \Delta \theta$ (fixed axis, θ in rad)</p> <p>Variable torque: $W = \int \tau_{axis} d\theta$ $W = \int \boldsymbol{\tau} \cdot \boldsymbol{\omega} dt$</p>	$W = QV_{drop}$ $W_{electric} = -q\Delta V$	<p><u>Thermodynamics:</u> $W = \int P dV$ $e = \left \frac{W}{Q_H} \right = \left \frac{\text{output/cycle}}{\text{heat absorbed}} \right$ Max. Carnot efficiency: $e_c = \frac{T_H - T_C}{T_H}$ (T_H, T_C in kelvins)</p>	¹ Needs steady, incompressible, inviscid flow along a streamline, with no pump/turbine work. ² Closed system; negligible changes in macroscopic kinetic and potential energy.
Kinetic Energy (J)	<p>Translational: $K_{trans} = \frac{1}{2}mv^2$</p> <p>Work-Energy Theorem: $W_{net} = \Delta K$ $W_{net} = W_{other} - \Delta U = W_{other} - \Delta U_g - \Delta U_s$ $\Delta K = K_2 - K_1 = \frac{1}{2}m(v_2^2 - v_1^2) + \frac{1}{2}I(\omega_2^2 - \omega_1^2)$</p>	<p>Rotational: $K_{rotat} = \frac{1}{2}I\omega^2$</p>	<p>1 eV $\approx 1.60 \times 10^{-19} \text{ J}$</p> <p>Mechanical Energy: $E_{mech} = K + U$ $K = K_{trans} + K_{rotat}$ $U = U_g + U_s$</p>	<p><u>Fluid Mechanics:</u> Bernoulli's Equation¹: $P_1 + \rho gy_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho gy_2 + \frac{1}{2}\rho v_2^2$</p> <p><u>Thermodynamics:</u> $K_{avg} = \frac{3}{2}k_B T$ (T is in kelvins)</p>	<p><u>Atomic and Nuclear:</u> $K_{max} = hf - \phi$ (emission requires $hf \geq \phi$)</p>
Potential Energy (J)	<p>Surface of Earth Gravity: $\Delta U_g = mg\Delta h$ $U_g = mgh$</p> <p>Planetary Gravity: $U_G = -G \frac{m_1 m_2}{r}$</p> <p>Conservation of Mechanical Energy: $\Delta E_{mech} =$ $\Delta(K + U_g + U_s) = 0$</p>	<p>Coiled Spring: $U_s = \frac{1}{2}k\Delta s^2$</p> <p>Nonconservative Work: $W_{noncons.} =$ $\Delta(K + U_g + U_s)$</p>	<p>Point charges: $U_E = qV$ $U_E = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r}$</p> <p>Capacitor/inductor: $U_C = \frac{1}{2}QV = \frac{1}{2}CV^2$ $U_L = \frac{1}{2}LI^2$</p>	<p><u>Fluid Mechanics:</u> $P = P_0 + \rho gh$</p> <p>Continuity of Mass: $\rho_1 A_1 v_1 = \rho_2 A_2 v_2$</p> <p>Continuity of Volume: $A_1 v_1 = A_2 v_2$</p> <p><u>Thermodynamics 1st Law²:</u> $\Delta U_{internal} = Q - W_{by}$</p>	<p><u>Atomic and Nuclear:</u> $E = hf$ $E_0 = mc^2$ $\Delta E = (\Delta m)c^2$</p> <p>Relativity: $E = mc^2 \left(\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \right)$</p>

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Heat Energy (J)	<p>Energy transferred by heating is Q.</p> <p>Closed-system energy balance: $Q > 0$ into the system $W_{by} > 0$ for work done by it</p>			<p><u>Thermodynamics:</u> $H = \frac{Q}{\Delta t} = \frac{kA\Delta T}{L}$ (steady heat conduction)</p> <p>$Q = mL_f$ $Q = mL_v$</p>	<p>Hydrogen Electron Energy Levels: $E_n = \frac{-13.6 \text{ eV}}{n^2}$ $n = \text{principal quantum number (1, 2, 3, etc.)}$</p>
Energy (J)	<p>Conservation of Energy for an isolated system: $E_{total} = E_i = E_f$</p> <p>$E_{total} = \sum E_i = \sum E_f$</p> <p>$E_{total} = K + U_{potential} + U_{internal}$</p> <p>Closed-system energy balance: $\Delta E_{total} = \Delta K + \Delta U_{potential} + \Delta U_{internal} = Q - W_{by}$</p>			<p>$\Delta E = Q = mc\Delta T = mc(T_f - T_i)$ (Heat is the only energy transfer, no phase change, and approximately constant specific heat)</p> <p>$T_f = \frac{m_1c_1T_{1i} + m_2c_2T_{2i}}{m_1c_1 + m_2c_2}$ (No heat exchange with surroundings, no phase change, negligible calorimeter heat capacity, constant specific heats)</p> <p>$c_{H_2O} = 4,184 \frac{J}{kg \cdot K}$</p>	
Power (W)	<p>$P_{ave} = \frac{\Delta E_{transferred}}{\Delta t}$</p> <p>$P = \mathbf{F} \cdot \mathbf{v}$</p> <p>Energy transferred by the process: $P = \frac{dE}{dt}$</p> <p>Efficiency: $\varepsilon = \frac{\text{power output}}{\text{power input}}$</p>	<p>$P = \frac{dW}{dt}$</p> <p>$P = \boldsymbol{\tau} \cdot \boldsymbol{\omega}$</p> <p>Energy transferred by the process: $P = \frac{dW}{dt}$</p>	<p>$P = IV$</p> <p>$P = I^2R$</p> <p>$P = \frac{V^2}{R}$</p>	<p>$P = \Delta p Q$</p> <p>where: $p = \text{pressure} \left(\frac{N}{m^2} \right)$ $Q = \text{volumetric flow rate} \left(\frac{m^3}{s} \right)$</p>	

	Mechanics: Linear Translation	Mechanics: Angular / Rotational	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)	$T = \frac{1}{f}$ $f = \frac{1}{T}$ <p>Kepler's Third Law:</p> $T^2 = \left(\frac{4\pi^2}{GM}\right)r^3$ <p>(M dominant; r is circular-orbit radius)</p>	$T = \frac{1}{f} = \frac{2\pi}{\omega} = \frac{2\pi r}{v}$ $T_{spring} = 2\pi\sqrt{\frac{m}{k}}$ $T_{pendulum} = 2\pi\sqrt{\frac{\ell}{g}}$ <p>(small oscillations)</p>	$T_{angular} = \frac{2\pi}{ b }$ <p>For:</p> $y = \sin(b\theta)$ $y = \cos(b\theta)$	 <p>Waves and Optics:</p> $f = \frac{v}{\lambda}$ <p>Doppler Effect:</p> $f_r = f_s \left(\frac{v \pm v_r}{v \mp v_s}\right)^*$ <p>* = Receiver toward source: numerator +; source toward receiver: denominator -, with speeds measured relative to the medium.</p>	
	Center of Mass (m)	$x_{CM} = \frac{m_1x_1 + m_2x_2}{m_1 + m_2}$ $r_{CM} = \frac{\sum mr}{\sum m}$ $\bar{x} = \frac{1}{M} \int_0^M x \, dm$ <p>where $M = \int_0^M dm$ and $dm = \rho \, dz \, dy \, dx$</p>		$x_{CM} = \frac{\sum m_i x_i}{\sum m_i}$ $y_{CM} = \frac{\sum m_i y_i}{\sum m_i}$ 	
Rigid Bodies (Statics)		$\sum F_x = 0$ <p>(Right = '+')</p> $\sum F_y = 0$ <p>(Down = '-')</p>	$\sum \tau = 0$ <p>(CW = '-')</p> $\sum \tau = \sum (F_{y,i} x_i - F_{x,i} y_i) = 0$		

	Mechanics: Linear Translation	Mechanics: Angular / Rotational	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	$\sum \mathbf{p}_i = \sum \mathbf{p}_f$ $\sum m\mathbf{v}_i = \sum m\mathbf{v}_f$	$\sum \mathbf{L}_i = \sum \mathbf{L}_f$ $\sum I\omega_i = \sum I\omega_f$	$\sum Q_i = \sum Q_f$	$\sum m_i = \sum m_f$	$\sum E_i = \sum E_f$
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.)	$\sum E_i = \text{constant}$ $\Delta E_{\text{total}} = \Delta K + \Delta U_{\text{potential}} + \Delta U_{\text{internal}} = Q - W_{\text{by}}$
					For an isolated system: $E_{\text{total}} = K + U_{\text{potential}} + U_{\text{internal}} = \text{constant}$

Electricity			
Terms	Formulas	See Harold's Electromagnetic Spectrum Cheat Sheet See Harold's DC Circuits Cheat Sheet	
Electric Field (V/m or N/C)	$\mathbf{E} = \frac{\mathbf{F}}{q}$ $E_{x,avg} = -\frac{\Delta V}{\Delta x}$ $\mathbf{E} = \rho \mathbf{J}$ <p>(ρ = electrical resistivity)</p>	$E_r = -\frac{dV}{dr}$ <p>Electrostatic:</p> $\mathbf{E} = -\nabla V$	<p>Gauss's Law:</p> $\phi = \oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q_{enc}}{\epsilon_0}$
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)	$I_{ave} = \frac{\Delta Q}{\Delta t}$ $I = \frac{V}{R}$	$I = \frac{dQ}{dt}$ $I = n e v_d A$	
Circuits		Series	Parallel
Circuit Terms	Resistor Capacitor Inductor		
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)	$L = N \frac{\Phi}{I}$ $L = \frac{V_L}{dI/dt}$ $L = \mu_0 \frac{N^2 A}{\ell}$	$L_s = \sum_i L_i$	$\frac{1}{L_p} = \sum_i \frac{1}{L_i}$
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)	$\sum_{i=1}^n I_i = 0$ <p>The algebraic sum of currents in a network of conductors meeting at a point (node) is zero.</p>		
Kirchhoff's Voltage Law (KVL)	$\sum_{i=1}^n V_i = 0$ <p>The directed sum of the potential differences (voltages) around any closed loop is zero.</p>	 KVL: $-v + v_1 + v_2 = 0$	

Magnetism		
	See Harold's Physics Maxwell's Equations Cheat Sheet	
Term	Formulas	Laws
Magnetic Field (T)	$B = \frac{\mu_0}{2\pi} \frac{I}{r}$ <p>(Long straight wire)</p> <p>Solenoid: $B_s = \mu_0 n I$ where $n = \frac{N}{\ell}$ turns per meter (Long air-core solenoid, away from the ends)</p> <p>Moving-charge magnetic-field: $\mathbf{B} = \frac{\mu_0}{4\pi} \frac{q\mathbf{v} \times \mathbf{r}}{r^3}$ $\mathbf{B} = \frac{\mu_0}{4\pi} \frac{q\mathbf{v} \times \hat{\mathbf{r}}}{r^2}$ (Nonrelativistic approximation, $v \ll c$. $\mathbf{r}$ points from the charge to the observation point.)</p>	<p>Ampère–Maxwell Law: $\oint \mathbf{B} \cdot d\boldsymbol{\ell} = \mu_0 I + \mu_0 \epsilon_0 \frac{d\Phi_E}{dt}$</p> <p>Gauss's Law: $\oint \mathbf{B} \cdot d\mathbf{A} = 0$</p> $d\mathbf{B} = \frac{\mu_0}{4\pi} \frac{I d\boldsymbol{\ell} \times \mathbf{r}}{r^3}$
Magnetic Flux (Wb)	$\phi_B = \mathbf{B} \cdot \mathbf{A}$ <p>(Uniform field through a flat surface; θ is measured from the surface normal)</p>	<p>Magnetic Flux: $\phi_B = \int \mathbf{B} \cdot d\mathbf{A}$</p>
EMF (V)	$\varepsilon = Blv$ <p>(magnitude; perpendicular rod, velocity, and uniform magnetic field)</p> $\varepsilon_{avg} = - \frac{N\Delta\phi_B}{\Delta t}$ <p>(N turns, stationary loop)</p> $\varepsilon = \oint \mathbf{E} \cdot d\mathbf{s} = - \frac{d\phi_B}{dt}$ <p>(single stationary loop)</p>	<p>Faraday's Law of Induction: $\oint \mathbf{E} \cdot d\boldsymbol{\ell} = - \frac{d\phi_B}{dt}$</p> $\varepsilon = -L \frac{dI}{dt}$

Sources

- Hibbeler, Russell C. (2022). [Engineering Mechanics – Dynamics](#). 15th Edition. Pearson.
- [NIST SP 961](#) (2022). CODATA Recommended Values of the Fundamental Physical Constants: 2022. https://physics.nist.gov/cuu/pdf/wall_2022.pdf
- Wikipedia (2025).
 - Metric prefix. https://en.wikipedia.org/wiki/Metric_prefix
 - SI derived unit. https://en.wikipedia.org/wiki/SI_derived_unit

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