PHY 201

$$x_\mathrm{f} = x_\mathrm{i} + v_\mathrm{i} t + \frac{1}{2} a t^2$$
$$v_\mathrm{f} = v_\mathrm{i} + at$$
$$v_\mathrm{f}^2 = v_\mathrm{i}^2 + 2a(x_\mathrm{f} - x_\mathrm{i})$$
$$v_\mathrm{avg} = \frac{1}{2}(v_\mathrm{f} + v_\mathrm{i})$$
$$\Delta\vec{r} = \vec{v}_\mathrm{avg}\Delta t$$
$$\vec{F}_\mathrm{net} \equiv \sum_i \vec{F}_i$$
$$\vec{F}_\mathrm{net} = m\vec{a}$$
$$F_g = w = mg$$
$$|\vec{F}_\mathrm{s}| \le \mu_\mathrm{s}|\vec{n}|$$
$$|\vec{F}_\mathrm{k}| = \mu_\mathrm{k}|\vec{n}|$$
$$\vec{F}_\mathrm{S} = -k\vec{x}$$
$$\omega = \frac{v_\mathrm{t}}{r}$$
$$a_\mathrm{c} = \frac{v_\mathrm{t}^2}{r} = r\omega^2$$
$$\vec{F}_G = -G\frac{m_1 m_2}{r^2}\hat{r}$$
$$g = G\frac{m_\mathrm{earth}}{r_\mathrm{earth}^2}$$
$$W = \vec{F}\cdot\vec{d} = |\vec{F}||\vec{d}|\cos(\theta)$$
$$\mathrm{KE} = K \equiv \frac{1}{2}mv^2$$
$$W_\mathrm{net} = \Delta K$$
$$W_\mathrm{cons} = -\Delta U = -\Delta\mathrm{PE}$$
$$\mathrm{PE}_g = U_g = mgh$$
$$U_G = -G\frac{m_1 m_2}{r}$$

$$\mathrm{PE_S} = U_\mathrm{S} = \frac{1}{2}kx^2$$
$$\vec{r}_\mathrm{cm} \equiv \frac{\sum_i m_i \vec{r}_i}{\sum_i m_i}$$
$$\vec{v}_\mathrm{cm} \equiv \frac{\sum_i m_i \vec{v}_i}{\sum_i m_i}$$
$$\vec{a}_\mathrm{cm} \equiv \frac{\sum_i m_i \vec{a}_i}{\sum_i m_i}$$
$$\vec{p} \equiv m\vec{v}$$
$$\vec{F} = \frac{\Delta\vec{p}}{\Delta t}$$
$$\vec{p}_{1,\mathrm{f}} + \vec{p}_{2,\mathrm{f}} = \vec{p}_{1,\mathrm{i}} + \vec{p}_{2,\mathrm{i}}\ .$$
$$\vec{\mathcal{J}} \equiv \vec{F}\Delta t = \Delta\vec{p}$$
$$\tau = rF\sin\theta$$
$$r_\perp = r\sin(\theta)$$
$$\tau = r_\perp F = I\alpha$$
$$\theta = \frac{s}{r}$$
$$\omega = \frac{\Delta\theta}{\Delta t} = \frac{v_\mathrm{t}}{r}$$
$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{a_\mathrm{t}}{r}$$
$$v = r\omega$$
$$\theta_\mathrm{f} = \theta_\mathrm{i} + \omega_\mathrm{i} t + \frac{1}{2}\alpha t^2$$
$$\omega_\mathrm{f} = \omega_\mathrm{i} + \alpha t$$
$$\omega_\mathrm{f}^2 = \omega_\mathrm{i}^2 + 2\alpha(\theta_\mathrm{f} - \theta_\mathrm{i})$$
$$\omega_\mathrm{avg} = \frac{1}{2}(\omega_\mathrm{f} + \omega_\mathrm{i})$$
$$L = rp\sin\theta = I\omega$$
$$L = r(mv)\sin\theta$$
$$\vec{\tau} = \frac{\Delta\vec{L}}{\Delta t}$$

$$W = \tau\Delta\theta$$
$$K_\mathrm{rot} = \frac{1}{2}I\omega^2$$
$$\omega = 2\pi f = \frac{2\pi}{T}$$
$$\omega = \sqrt{\frac{k}{m}}$$
$$\omega = \sqrt{\frac{g}{\ell}}$$
$$\omega = \sqrt{\frac{mg\ell_\mathrm{cm}}{I}}$$
$$x(t) = x_\mathrm{max}\sin(\omega t)$$
$$v(t) = \omega x_\mathrm{max}\cos(\omega t)$$
$$a(t) = -\omega^2 x_\mathrm{max}\sin(\omega t)$$
$$E = \frac{1}{2}kx_\mathrm{max}^2$$
$$v = f\lambda$$
$$\mu \equiv \frac{m}{\ell}$$
$$v = \sqrt{\frac{F}{\mu}}$$
$$k \equiv \frac{2\pi}{\lambda}$$
$$y_\mathrm{sw}(x,t) = \left[A\sin(kx)\right]\sin(\omega t)$$
$$f_\mathrm{string} = f_\mathrm{open-open} = n\left(\frac{v}{2\ell}\right)$$
where $n \in \{1, 2, 3, \ldots\}$
$$\ell = n\frac{\lambda_n}{2}$$
where $n \in \{1, 2, 3, \ldots\}$

$$f_\mathrm{open-closed} = n\left(\frac{v}{4\ell}\right)$$
where $n \in \{1, 3, 5, \ldots\}$
$$\ell = n\frac{\lambda_n}{4}$$
where $n \in \{1, 3, 5, \ldots\}$
$$y_\mathrm{tw}(x,t) = A\sin(kx \mp \omega t)$$
$$f_\mathrm{o} = f_\mathrm{s}\left(\frac{v \pm v_\mathrm{o}}{v \mp v_\mathrm{s}}\right)$$
$$f_\mathrm{beat} = |f_2 - f_1|$$
$$I = \frac{P}{A}$$
$$I = \frac{P}{4\pi r^2}$$
$$I_0 \equiv 1.0 \times 10^{-12}\,\frac{\mathrm{W}}{\mathrm{m}^2}$$
$$\beta[\mathrm{dB}] = 10\log_{10}\left(\frac{I}{I_0}\right)$$
$$P = \frac{F}{A}$$
$$\rho = \frac{m}{V}$$
$$F_\mathrm{b} = \rho V g$$
$$P = P_0 + \rho g h$$
$$P + \rho g y + \frac{1}{2}\rho v^2 = \mathrm{const}$$
$$Q = \Phi_v \equiv \vec{v}\cdot\vec{A} = vA\cos(\theta)$$
$$Q = \frac{\Delta V}{\Delta t}$$
$$A_1 v_1 = A_2 v_2$$
$$\rho v A = \frac{\Delta m}{\Delta t}$$

Moments of Inertia

hoop about axis $I = mr^2$

point particle about axis at distance r $I = mr^2$

ring about axis $I = \frac{1}{2}m\left(r_1^2 + r_2^2\right)$

solid disk about axis $I = \frac{1}{2}mr^2$

solid disk about diameter $I = \frac{1}{4}mr^2 + \frac{1}{12}m\ell^2$

thin rod, axis through center $\perp$ to length $I = \frac{1}{12}m\ell^2$

thin rod, axis through end $\perp$ to length $I = \frac{1}{3}m\ell^2$

solid sphere about diameter $I = \frac{2}{5}mr^2$

thin spherical shell about diameter $I = \frac{2}{3}mr^2$

hoop about any diameter $I = \frac{1}{2}mr^2$

slab about $\perp$ axis through center $I = \frac{1}{2}m\left(\ell_x^2 + \ell_y^2\right)$

circumference of a circle $C = 2\pi r$

area of a circle $A = \pi r^2$

surface area of a sphere $A = 4\pi r^2$

volume of a sphere $V = \frac{4}{3}\pi r^3$

If $Ax^2 + Bx + C = 0$, $x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$

$$\log_a(xy) = \log_a(x) + \log_a(y)$$

$$\log_a\left(\frac{x}{y}\right) = \log_a(x) - \log_a(y)$$

$$\log_a(x^y) = y\log_a(x)$$

If $a^x = y$, $x = \log_a y = \frac{\log_{10} y}{\log_{10} a} = \frac{\ln y}{\ln a}$

If $|\theta| < 0.5$ radians, $\sin(\theta) \approx \theta$ (in radians)

If $|\theta| < 0.5$ radians, $\tan(\theta) \approx \theta$ (in radians)

$$\sin(-\theta) = -\sin(\theta)$$

$$\cos(-\theta) = \cos(\theta)$$

$$\sin(\theta_A + \theta_B) = \sin(\theta_A)\cos(\theta_B) + \cos(\theta_A)\sin(\theta_B)$$

$$\cos(\theta_A + \theta_B) = \cos(\theta_A)\cos(\theta_B) - \sin(\theta_A)\sin(\theta_B)$$

$$\sin(\theta_A)\sin(\theta_B) = \frac{\cos(\theta_A - \theta_B) - \cos(\theta_A + \theta_B)}{2}$$

$$\cos(\theta_A)\cos(\theta_B) = \frac{\cos(\theta_A - \theta_B) + \cos(\theta_A + \theta_B)}{2}$$

$$\sin(\theta_A)\cos(\theta_B) = \frac{\sin(\theta_A - \theta_B) + \sin(\theta_A + \theta_B)}{2}$$

Law of Cosines $c^2 = a^2 + b^2 - 2ab\cos(C)$

Law of Sines $\frac{a}{\sin(A)} = \frac{b}{\sin(B)} = \frac{c}{\sin(C)}$

$$\left.\begin{aligned} x &= r\cos(\theta) \\ y &= r\sin(\theta) \end{aligned}\right\} \Longleftrightarrow \left\{\begin{aligned} r &= \sqrt{x^2+y^2} \\ \theta &= \tan^{-1}(y/x) + \begin{cases} 0^\circ, & \text{if } x > 0 \\ 180^\circ, & \text{otherwise} \end{cases} \end{aligned}\right.$$

If $\vec{R} = \vec{A} + \vec{B}$, $R_x = A_x + B_x$ and $R_y = A_y + B_y$

If $\vec{R} = \vec{A} - \vec{B}$, $R_x = A_x - B_x$ and $R_y = A_y - B_y$

$$\vec{A}\cdot\vec{B} = \vec{B}\cdot\vec{A} = A_xB_x + A_yB_y + A_zB_z = |\vec{A}||\vec{B}|\cos(\theta)$$

$$|\vec{A}\times\vec{B}| = |\vec{A}||\vec{B}||\sin(\theta)|$$

Newton's constant $G = 6.67430\times10^{-11}\ \frac{\mathrm{m}^3}{\mathrm{kg}\cdot\mathrm{s}^2}$

speed of light $c \equiv 2.99792458 \times 10^8$ m/s

elementary charge $e = 1.602176634\times10^{-19}$ C

electrostatic constant $k = 8.987551792\times10^9\ \frac{\mathrm{N}\cdot\mathrm{m}^2}{\mathrm{C}^2}$

vacuum permittivity $\epsilon_0 = 8.854187813\times10^{-12}$ F/m

vacuum permeability

$$\mu_0 = 1.2566370621\times10^{-6}\ \mathrm{N}\cdot\mathrm{A}^{-2}$$
$$\approx 4\pi\times10^{-7}\ \mathrm{N}\cdot\mathrm{A}^{-2}$$

Planck's constant $h = 6.62607015\times10^{-34}$ J · s

$$\hbar \equiv \frac{h}{2\pi} = 1.054571817\times10^{-34}\ \mathrm{J}\cdot\mathrm{s}$$

standard gravity $g = +9.80665\ \frac{\mathrm{m}}{\mathrm{s}^2}$

mass of earth $m_{\text{earth}} = 5.9723\times10^{24}$ kg

mass of moon $m_{\text{moon}} = 7.346\times10^{22}$ kg

mass of sun $m_{\text{sun}} = 1.9885\times10^{30}$ kg

mass of electron $m_{\text{e}} = 9.1093837015\times10^{-31}$ kg

mass of proton $m_{\text{p}} = 1.67262192369\times10^{-27}$ kg

mass of neutron $m_{\text{n}} = 1.67492749804\times10^{-27}$ kg

volumetric radius of earth $r_{\text{earth}} = 6.371\times10^6$ m

earth-moon distance $r_{\text{EM}} = 3.844\times10^8$ m

earth-sun distance $r_{\text{ES}} = 1.496\times10^{11}$ m

Density of air at sea level at 15° C:

$$\rho_0 = 1.225\frac{\mathrm{kg}}{\mathrm{m}^3}$$

Earth's total magnetic field strength at Huntington, WV:

$$|\vec{B}_{\text{earth}}| \approx 5.15\times10^{-5}\ \mathrm{T}$$

Vertical component of Earth's magnetic field strength at Huntington, WV:

$$B_{\text{earth},z} \approx 4.70\times10^{-5}\ \mathrm{T}$$

Bohr radius $a_B \equiv \frac{\hbar^2}{m_e k e^2} = 5.29177210903\times10^{-11}$ m

Rydberg constant $\mathcal{R} \equiv \frac{\hbar}{4\pi m_e a_B^2 c} = 1.0973731568160 \times 10^7\ \mathrm{m}^{-1}$

hydrogen binding energy $E_0 = 13.605693123$ eV

scale for nuclear radius $r_{\text{nuc}} = 1.2\times10^{-11}$ m

$$1 \text{ newton [N]} \equiv 1 \ \frac{\text{kilogram} \cdot \text{meter}}{\text{second}^2}$$

$$1 \text{ joule [J]} \equiv 1 \text{ newton} \cdot \text{meter}$$

$$1 \text{ watt [W]} = 1 \ \frac{\text{joule}}{\text{second}}$$

$$1 \text{ radian} \equiv \frac{180^\circ}{\pi} \approx 57.29577951^\circ$$

$$1 \ \frac{\text{radian}}{\text{second}} \equiv \frac{60}{2\pi} \text{ rpm} \approx 9.549296586 \text{ rpm}$$

$$1 \text{ hertz [Hz]} \equiv 1 \text{ second}^{-1}$$

$$1 \text{ pascal [Pa]} \equiv 1 \ \frac{\text{newton}}{\text{meter}^2}$$

$$1 \text{ volt [V]} \equiv 1 \ \frac{\text{joule}}{\text{coulomb}}$$

$$1 \text{ electron} - \text{volt [eV]} = 1.602176565 \times 10^{-19} \text{joule}$$

$$1 \text{ farad [F]} \equiv 1 \ \frac{\text{coulomb}}{\text{volt}}$$

$$1 \text{ ampere [A]} \equiv 1 \ \frac{\text{coulomb}}{\text{second}}$$

$$1 \text{ ohm } [\Omega] \equiv 1 \ \frac{\text{volt}}{\text{ampere}}$$

$$1 \text{ tesla} \equiv 1 \ \frac{\text{newton}}{\text{ampere} \cdot \text{meter}}$$

$$1 \text{ gauss [G]} \equiv 10^{-4} \text{ tesla}$$

$$1 \text{ henry [H]} \equiv 1 \text{ ohm} \cdot \text{second}$$

$$1 \text{ diopter [D]} \equiv 1 \text{ meter}^{-1}$$

$$1 \text{ dalton [u]} = 1.66053873 \times 10^{-27} \text{ kilogram}$$

$$1 \text{ becquerel [Bq]} \equiv 1 \frac{\text{decay}}{\text{second}}$$

$$1 \text{ curie [Ci]} \equiv 3.7 \times 10^{10} \text{ becquerel}$$

$$1 \text{ rad} \equiv 0.01 \ \frac{\text{joule}}{\text{kilogram}}$$

$$1 \text{ gray} \equiv 1 \ \frac{\text{joule}}{\text{kilogram}} = 100 \text{ rad}$$

$$1 \text{ rem} \equiv 1 \text{ rad} \cdot RBE$$

$$1 \text{ sievert [Sv]} \equiv 1 \text{ gray} \cdot RBE = 100 \text{ rem}$$

$$1 \text{ inch [in]} \equiv 0.0254 \text{ meter}$$

$$1 \text{ foot [ft]} = 0.3048 \text{ meter}$$

$$1 \text{ mile [mi]} = 1609.344 \text{ meter}$$

$$1 \text{ light year [ly]} = 9.4605284 \times 10^{15} \text{ meter}$$

$$1 \text{ ouncemass [oz]} = 0.02835 \text{ kilogram}$$

$$1 \text{ poundmass [lb]} = 0.4536 \text{ kilogram}$$

$$1 \text{ mile per hour [mph]} = 0.44704 \ \frac{\text{meter}}{\text{second}}$$

$$1 \text{ foot pound [ft} \cdot \text{lb]} = 1.3558179 \text{ joule}$$

$$1 \text{ centipoise [cP]} \equiv 0.1 \text{ pascal} \cdot \text{second}$$

$$1 \text{ kiloton [kt]} = 4.184 \times 10^{12} \text{ joule}$$

$$1 \text{ horsepower [hp]} = 745.69987 \text{ watt}$$

$$1 \text{ atmosphere [atm]} = 1.0132501 \times 10^{5} \text{ pascal}$$

$$1 \text{ mm of mercury [mmHg]} = 133.32239 \text{ pascal}$$

$$1 \text{ pound per square inch [psi]} = 6894.75728 \text{ pascal}$$

Prefixes

giga [G]: 10^{9}	centi [c]: 10^{-2}	nano [n]: 10^{-9}
mega [M]: 10^{6}	milli [m]: 10^{-3}	pico [p]: 10^{-12}
kilo [k]: 10^{3}	micro [μ]: 10^{-6}	femto [f]: 10^{-15}

PHY 203

$$q = Ne$$
$$\vec{F} = k\frac{q_1 q_2}{r^2}\hat{r}$$
$$\vec{E} \equiv \frac{\vec{F}}{q}$$
$$\vec{E} = k\frac{q}{r^2}\hat{r}$$
$$\text{PE} = U = k\frac{q_1 q_2}{r}$$
$$\mathcal{V} \equiv \frac{U}{q} = \frac{-\text{W}}{q}$$
$$\mathcal{V} = k\frac{q}{r}$$
$$E_x = -\frac{\Delta\mathcal{V}(x)}{\Delta x}$$
$$\Phi_E = \vec{E}\cdot\vec{A} = A|\vec{E}|\cos\theta$$
$$\Phi_E = \frac{q_{\text{enclosed}}}{\epsilon_0}$$
$$C \equiv \frac{q}{\mathcal{V}}$$
$$C = \frac{\kappa\epsilon_0 A}{d}$$
$$\frac{1}{C_{\text{series}}} = \frac{1}{C_1} + \frac{1}{C_2} + \dots$$
$$C_{\text{parallel}} = C_1 + C_2 + \dots$$
$$U = \frac{1}{2}q\mathcal{V}$$
$$U = \frac{1}{2}\frac{q^2}{C}$$
$$U = \frac{1}{2}C\mathcal{V}^2$$
$$u = \frac{\epsilon_0}{2}|\vec{E}|^2$$
$$I = \frac{\Delta q}{\Delta t}$$
$$\vec{I} = nqA\vec{v}_{\text{drift}}$$
$$q\vec{v} = I\vec{\ell}$$
$$\mathcal{V} = IR$$
$$R = \frac{\rho\ell}{A}$$
$$\rho = \rho_0(1 + \alpha\Delta T)$$
$$R = R_0(1 + \alpha\Delta T)$$
$$P = I\mathcal{V}$$
$$P = \frac{\mathcal{V}^2}{R}$$
$$P = I^2 R$$
$$\mathcal{V}(t) = \mathcal{V}_0\sin(\omega t)$$
$$P_{\text{avg}} = \frac{1}{2}I_0\mathcal{V}_0$$
$$P_{\text{avg}} = I_{\text{RMS}}\mathcal{V}_{\text{RMS}}$$
$$R_{\text{series}} = R_1 + R_2 + \dots$$
$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$
$$\tau = RC$$
$$I(t) = I_{\max}e^{-t/\tau}$$
$$\mathcal{V}_R(t) = \mathcal{V}_{\text{battery}}e^{-t/\tau}$$
$$\mathcal{V}_C = \mathcal{V}_{\text{battery}}\left(1 - e^{-t/\tau}\right)$$
$$\mathcal{V}_R(t) = \mathcal{V}_{\max}e^{-t/\tau}$$
$$\mathcal{V}_C = -\mathcal{V}_{\max}e^{-t/\tau}$$
$$\vec{F}_B = q\vec{v}\times\vec{B}$$
$$F_B = qvB\sin\theta$$
$$F = I\ell B\sin\theta$$
$$\mu = NIA$$
$$\tau = \mu B\sin\theta$$
$$U = -\mu B\cos\theta$$
$$B = \frac{\mu_0 I}{2\pi r}$$
$$B = \frac{N\mu_0 I}{2r}$$
$$B = \frac{N\mu_0 I}{\ell} = n\mu_0 I$$
$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi r}$$
$$\Phi_B \equiv \vec{B}\cdot\vec{A} = BA\cos(\theta)$$
$$\text{EMF} = -\frac{\Delta\Phi_{\text{tot}}}{\Delta t} = -N\frac{\Delta\Phi_1}{\Delta t}$$
$$\text{EMF} = NAB\omega\sin(\omega t)$$
$$\frac{\mathcal{V}_{\text{S}}}{\mathcal{V}_{\text{P}}} = \frac{N_{\text{S}}}{N_{\text{P}}} = \frac{I_{\text{P}}}{I_{\text{S}}}$$
$$\text{EMF} = -L\frac{\Delta I}{\Delta t}$$
$$U = \frac{1}{2}LI^2$$
$$u = \frac{1}{2\mu_0}B^2$$
$$\tau = \frac{L}{R}$$
$$X_C = \frac{1}{2\pi fC} = \frac{1}{\omega C}$$
$$X_L = 2\pi fL = \omega L$$
$$I_{\text{RMS}} = \frac{\mathcal{V}_{\text{RMS}}}{|Z|}$$
$$|Z_{\text{total}}| = \sqrt{R^2 + (X_L - X_C)^2}$$
$$\tan\phi = \frac{X_L - X_C}{R}$$
$$\omega_{\text{res}} = 2\pi f_{\text{res}} = \frac{1}{\sqrt{LC}}$$
$$P_{\text{avg}} = I_{\text{RMS}}\mathcal{V}_{\text{RMS}}\cos\phi$$
$$|\vec{E}| = c|\vec{B}|$$
$$c = \frac{1}{\sqrt{\mu_0\epsilon_0}}$$
$$v = f\lambda$$
$$I_{\text{avg}} = \frac{|\vec{E}_{\max}||\vec{B}_{\max}|}{2\mu_0}$$
$$n \equiv \frac{c}{v}$$
$$n_1\sin(\theta_1) = n_2\sin(\theta_2)$$
$$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$
$$P = \frac{1}{f} = \frac{1}{d_{\text{O}}} + \frac{1}{d_{\text{I}}}$$
$$\frac{1}{f} = \left(\frac{n_{\text{l}} - n_{\text{m}}}{n_{\text{m}}}\right)\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$
$$m \equiv \frac{h_{\text{I}}}{h_{\text{O}}} = -\frac{d_{\text{I}}}{d_{\text{O}}}$$
$$f = \frac{r}{2}$$
$$m = m_{\text{objective}}\, m_{\text{eyepiece}}$$
$$m \sim \left(\frac{\text{N.P.}}{f_{\text{e}}}\right)\left(\frac{\ell - f_{\text{e}}}{d_{\text{o}}}\right)$$
$$M = \frac{\theta_{\text{telescope}}}{\theta_{\text{naked eye}}} = -\frac{f_{\text{o}}}{f_{\text{e}}}$$
$$d\sin(\theta) = m\lambda$$
where $m \in \{0, \pm1, \pm2, \dots\}$
$$d\sin(\theta) = \left(m - \frac{1}{2}\right)\lambda$$
where $m \in \{1, 2, \dots\}$
$$2t = m\lambda$$
where $m \in \{0, 1, 2, \dots\}$
$$2t = \left(m - \frac{1}{2}\right)\lambda$$
where $m \in \{1, 2, 3, \dots\}$
$$\sin(\theta) = 1.22\frac{\lambda}{D}$$
$$E = \Delta mc^2$$
$$E = hf = pc$$
$$E = hf = \hbar\omega = \frac{hc}{\lambda}$$
$$(\Delta x)(\Delta p) \geq \frac{\hbar}{2}$$
$$(\Delta t)(\Delta E) \geq \frac{\hbar}{2}$$
$$r_n = \frac{n^2}{Z}a_{\text{B}}$$
$$n\lambda_n = \frac{nh}{m_{\text{e}}v_n} = 2\pi r_n$$
$$E_n = -\frac{Z^2}{n^2}(13.86\text{ eV})$$
$$\frac{1}{\lambda} = \left(\frac{1}{n_{\text{f}}^2} - \frac{1}{n_{\text{i}}^2}\right)\mathcal{R}$$
$$Q = (M_A + M_B - M_C - M_D)c^2$$
$$|\vec{L}| = m_{\text{e}}vr_n = n\hbar$$
$$N(t) = N_0 e^{-\lambda t} = N_0 2^{-t/t_{1/2}}$$
$$\lambda = \frac{\ln 2}{t_{1/2}}$$
$$R \equiv \frac{\Delta N}{\Delta t}$$
$$R = N\lambda = \frac{N\ln 2}{t_{1/2}}$$
$$r = r_{\text{nuc}}A^{1/3}$$

Hydrogen Spectrum Series

Lymann: $n_{\text{f}} = 1$

Balmer: $n_{\text{f}} = 2$

Paschen: $n_{\text{f}} = 3$