

PHY 201

$$\vec{v} = \frac{\Delta \vec{r}}{\Delta t}$$

$$x_f = x_i + v_i t + \frac{1}{2} a t^2$$

$$v_f = v_i + a t$$

$$v_f^2 = v_i^2 + 2a(x_f - x_i)$$

$$v_{\text{avg}} = \frac{1}{2}(v_f + v_i)$$

$$\Delta \vec{r} = \vec{v}_{\text{avg}} \Delta t$$

$$\vec{F}_{\text{net}} \equiv \sum_i \vec{F}_i$$

$$\vec{F}_{\text{net}} = m \vec{a}$$

$$F_g = w = mg$$

$$|\vec{F}_s| \leq \mu_s |\vec{n}|$$

$$|\vec{F}_k| = \mu_k |\vec{n}|$$

$$\vec{F}_S = -k \vec{x}$$

$$\omega = \frac{v_t}{r}$$

$$a_c = \frac{v_t^2}{r} = r \omega^2$$

$$F_G = G \frac{m_1 m_2}{r^2}$$

$$g = G \frac{m_{\text{earth}}}{r_{\text{earth}}^2}$$

$$W = \vec{F} \cdot \vec{d} = |\vec{F}| |\vec{d}| \cos(\theta)$$

$$P_{\text{av}} = \frac{\Delta W}{\Delta t}$$

$$KE = K \equiv \frac{1}{2} m v^2$$

$$W_{\text{net}} = \Delta K$$

$$W_{\text{cons}} = -\Delta U = -\Delta PE$$

$$PE_g = U_g = mgh$$

$$U_G = -G \frac{m_1 m_2}{r}$$

$$PE_S = U_S = \frac{1}{2} k x^2$$

$$\vec{r}_{\text{cm}} \equiv \frac{\sum_i m_i \vec{r}_i}{\sum_i m_i}$$

$$\vec{v}_{\text{cm}} \equiv \frac{\sum_i m_i \vec{v}_i}{\sum_i m_i}$$

$$\vec{a}_{\text{cm}} \equiv \frac{\sum_i m_i \vec{a}_i}{\sum_i m_i}$$

$$\vec{p} \equiv m \vec{v}$$

$$\vec{F} = \frac{\Delta \vec{p}}{\Delta t}$$

$$\vec{p}_{1,f} + \vec{p}_{2,f} = \vec{p}_{1,i} + \vec{p}_{2,i}$$

$$\vec{J} \equiv \vec{F} \Delta t = \Delta \vec{p}$$

$$\tau = r F \sin \theta$$

$$r_{\perp} = r \sin(\theta)$$

$$\sum \tau = r_{\perp} F = I \alpha$$

$$\theta = \frac{s}{r}$$

$$\omega = \frac{\Delta \theta}{\Delta t} = \frac{v_t}{r}$$

$$\alpha = \frac{\Delta \omega}{\Delta t} = \frac{a_t}{r}$$

$$v = r \omega$$

$$\theta_f = \theta_i + \omega_i t + \frac{1}{2} \alpha t^2$$

$$\omega_f = \omega_i + \alpha t$$

$$\omega_f^2 = \omega_i^2 + 2\alpha(\theta_f - \theta_i)$$

$$\omega_{\text{avg}} = \frac{1}{2}(\omega_f + \omega_i)$$

$$L = r p \sin \theta = I \omega$$

$$L = r(mv) \sin \theta$$

$$\vec{\tau} = \frac{\Delta \vec{L}}{\Delta t}$$

$$W = \tau \Delta \theta$$

$$K_{\text{rot}} = \frac{1}{2} I \omega^2$$

$$\omega = 2\pi f = \frac{2\pi}{T}$$

$$\omega = \sqrt{\frac{k}{m}}$$

$$\omega = \sqrt{\frac{g}{\ell}}$$

$$\omega = \sqrt{\frac{mg \ell_{\text{cm}}}{I}}$$

$$T = 2\pi \sqrt{\frac{L}{g}}$$

$$T = \sqrt{\frac{I}{mg \ell_{\text{cm}}}}$$

$$x(t) = x_{\text{max}} \cos(\omega t)$$

$$v(t) = -\omega x_{\text{max}} \sin(\omega t)$$

$$a(t) = -\omega^2 x_{\text{max}} \cos(\omega t)$$

$$E = \frac{1}{2} k x_{\text{max}}^2$$

$$v = f \lambda$$

$$\mu \equiv \frac{m}{\ell}$$

$$v = \sqrt{\frac{F}{\mu}}$$

$$k \equiv \frac{2\pi}{\lambda}$$

$$y_{\text{sw}}(x, t)$$

$$= [A \sin(kx)] \sin(\omega t)$$

$$f_{\text{string}} = f_{\text{open-open}} = n \left(\frac{v}{2\ell} \right)$$

$$\text{where } n \in \{1, 2, 3, \dots\}$$

$$\ell = n \frac{\lambda_n}{2}$$

$$\text{where } n \in \{1, 2, 3, \dots\}$$

$$f_{\text{open-closed}} = n \left(\frac{v}{4\ell} \right)$$

$$\text{where } n \in \{1, 3, 5, \dots\}$$

$$\ell = n \frac{\lambda_n}{4}$$

$$\text{where } n \in \{1, 3, 5, \dots\}$$

$$y_{\text{tw}}(x, t) = A \sin(kx \mp \omega t)$$

$$f_o = f_s \left(\frac{v \pm v_o}{v \mp v_s} \right)$$

$$f_{\text{beat}} = |f_2 - f_1|$$

$$P = \frac{F}{A}$$

$$\rho = \frac{m}{V}$$

$$F_b = \rho V g$$

$$P = P_0 + \rho g h$$

$$P + \rho g y + \frac{1}{2} \rho v^2 = \text{const}$$

$$Q = \Phi_v \equiv \vec{v} \cdot \vec{A} = v A \cos(\theta)$$

$$Q = \frac{\Delta V}{\Delta t}$$

$$A_1 v_1 = A_2 v_2$$

$$\rho v A = \frac{\Delta m}{\Delta t}$$

Moments of Inertia

$$\text{hoop about axis } I = mr^2$$

$$\text{point particle about axis at distance } r \quad I = mr^2$$

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

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

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

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

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

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

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

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

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

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

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

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 $R_y = A_y - B_y$

Newton's constant $G = 6.67430 \times 10^{-11} \frac{\text{m}^3}{\text{kg} \cdot \text{s}^2}$

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

elementary charge $e = 1.602176634 \times 10^{-19} \text{ C}$

electrostatic constant $k = 8.987551792 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}$

vacuum permittivity $\epsilon_0 = 8.854187813 \times 10^{-12} \text{ F/m}$

vacuum permeability

$\mu_0 = 1.2566370621 \times 10^{-6} \text{ N} \cdot \text{A}^{-2}$

$\approx 4\pi \times 10^{-7} \text{ N} \cdot \text{A}^{-2}$

Planck's constant $h = 6.62607015 \times 10^{-34} \text{ J} \cdot \text{s}$

$\hbar \equiv \frac{h}{2\pi} = 1.054571817 \times 10^{-34} \text{ J} \cdot \text{s}$

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

mass of earth $m_{\text{earth}} = 5.9723 \times 10^{24} \text{ kg}$

mass of moon $m_{\text{moon}} = 7.346 \times 10^{22} \text{ kg}$

mass of sun $m_{\text{sun}} = 1.9885 \times 10^{30} \text{ kg}$

mass of electron $m_e = 9.1093837015 \times 10^{-31} \text{ kg}$

$\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A} = A_x B_x + A_y B_y + A_z B_z = |\vec{A}||\vec{B}| \cos(\theta)$

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

mass of proton $m_p = 1.67262192369 \times 10^{-27} \text{ kg}$

mass of neutron $m_n = 1.67492749804 \times 10^{-27} \text{ kg}$

volumetric radius of earth $r_{\text{earth}} = 6.371 \times 10^6 \text{ m}$

earth-moon distance $r_{\text{EM}} = 3.844 \times 10^8 \text{ m}$

earth-sun distance $r_{\text{ES}} = 1.496 \times 10^{11} \text{ m}$

Density of air at sea level at 15° C :

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

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

$|\vec{B}_{\text{earth}}| \approx 5.15 \times 10^{-5} \text{ T}$

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

$B_{\text{earth},z} \approx 4.70 \times 10^{-5} \text{ T}$

Bohr radius $a_B \equiv \frac{\hbar^2}{m_e k e^2} = 5.29177210903 \times 10^{-11} \text{ m}$

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

hydrogen binding energy $E_0 = 13.605693123 \text{ eV}$

scale for nuclear radius $r_{\text{nuc}} = 1.2 \times 10^{-11} \text{ m}$

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

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

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

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

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

$$\approx 9.549296586 \text{ rpm}$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$q = Ne$$

$$F = k \frac{|q_1 q_2|}{r^2}$$

$$\vec{E} \equiv \frac{\vec{F}}{q}$$

$$E = k \frac{|q|}{r^2}$$

$$PE = U = k \frac{q_1 q_2}{r}$$

$$V \equiv \frac{U}{q} = \frac{-W}{q}$$

$$V = k \frac{q}{r}$$

$$E_x = -\frac{\Delta V(x)}{\Delta x}$$

$$\Phi_E = \vec{E} \cdot \vec{A} = A|\vec{E}| \cos \theta$$

$$\Phi_E = \frac{q_{\text{enclosed}}}{\epsilon_0}$$

$$C \equiv \frac{q}{V}$$

$$C = \frac{\kappa \epsilon_0 A}{d}$$

$$\frac{1}{C_{\text{series}}} = \frac{1}{C_1} + \frac{1}{C_2} + \dots$$

$$C_{\text{parallel}} = C_1 + C_2 + \dots$$

$$U_E = \frac{1}{2} qV = \frac{1}{2} \frac{q^2}{C} = \frac{1}{2} CV^2$$

$$u_E = \frac{1}{2} \epsilon_0 |\vec{E}|^2$$

$$I = \frac{\Delta q}{\Delta t}$$

$$\vec{I} = nqA\vec{v}_{\text{drift}}$$

$$V = IR$$

$$R = \frac{\rho \ell}{A}$$

$$\rho = \rho_0(1 + \alpha \Delta T)$$

$$R = R_0(1 + \alpha \Delta T)$$

$$P = IV = \frac{V^2}{R} = I^2 R$$

$$R_{\text{series}} = R_1 + R_2 + \dots$$

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

$$Q_{\text{max}} = \mathcal{E}C$$

$$\tau_C = RC$$

$$I(t) = I_{\text{max}} e^{-t/\tau}$$

$$V_C = V_{\text{battery}} (1 - e^{-t/\tau})$$

$$I(t) = -I_{\text{max}} e^{-t/\tau}$$

$$V_C = V_{\text{battery}} e^{-t/\tau}$$

$$F_B = qv_{\perp} B = qvB \sin \theta$$

$$R = \frac{mv_{\perp}}{qB}$$

$$F = I\ell B \sin \theta$$

$$\mu = NIA$$

$$\tau = \mu B \sin \theta$$

$$U = -\mu B \cos \theta$$

$$B_{\text{wire}} = \frac{\mu_0 I}{2\pi r}$$

$$B_{\text{loop}} = \frac{N\mu_0 I}{2r}$$

$$B_{\text{solenoid}} = \frac{N\mu_0 I}{\ell} = n\mu_0 I$$

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi r}$$

$$\mathcal{E} = v_{\perp} B \ell = vB\ell \sin \theta$$

$$\Phi_B \equiv \vec{B} \cdot \vec{A} = BA \cos \theta$$

$$\mathcal{E} = -\frac{\Delta \Phi_{\text{tot}}}{\Delta t} = -N \frac{\Delta \Phi_1}{\Delta t}$$

$$\mathcal{E} = NAB\omega \sin(\omega t)$$

$$\mathcal{E} = -L \frac{\Delta I}{\Delta t}$$

$$L = \mu_0 \left(\frac{N^2}{\ell} \right) A$$

$$U_B = \frac{1}{2} LI^2$$

$$u_B = \frac{1}{2\mu_0} B^2$$

$$\tau_L = \frac{L}{R}$$

$$I(t) = \frac{V_{\text{battery}}}{R} (1 - e^{-t/\tau})$$

$$|\vec{E}| = c|\vec{B}|$$

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$

$$v = f\lambda$$

$$I = \frac{P_{\text{source}}}{A} = \frac{P_{\text{source}}}{4\pi r^2}$$

$$I = \frac{1}{2} c \epsilon_0 E_0^2 = \frac{1}{2} \frac{c}{\mu_0} B_0^2$$

$$I_p = \frac{1}{2} I_0 (\cos \theta)^2$$

$$E_{\text{photon}} = hf$$

$$\frac{Q}{\Delta t} = e\sigma AT^4$$

$$\lambda_{\text{peak}} = \frac{b}{T}$$

$$v(t) = V_0 \cos(\omega t)$$

$$I_{\text{rms}} = \frac{I_{\text{peak}}}{\sqrt{2}}$$

$$V_{\text{rms}} = \frac{V_{\text{peak}}}{\sqrt{2}}$$

$$X_C = \frac{1}{2\pi fC} = \frac{1}{\omega C}$$

$$X_L = 2\pi fL = \omega L$$

$$I_{\text{rms}} = \frac{V_{\text{rms}}}{|Z|}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$P_{\text{avg}} = I_{\text{rms}} V_{\text{rms}} \cos \phi$$

$$P_{\text{avg}} = \frac{1}{2} I_{\text{peak}} V_{\text{peak}} = I_{\text{rms}} V_{\text{rms}}$$

$$\tan \phi = \frac{X_L - X_C}{R}$$

$$\omega_{\text{res}} = 2\pi f_{\text{res}} = \frac{1}{\sqrt{LC}}$$

$$\frac{V_S}{V_P} = \frac{N_S}{N_P} = \frac{I_P}{I_S}$$

$$n \equiv \frac{c}{v}$$

$$n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$$

$$\theta_c = \sin^{-1} \left(\frac{n_2}{n_1} \right)$$

$$P = \frac{1}{f} = \frac{1}{s} + \frac{1}{s'}$$

$$\frac{1}{f} = \left(\frac{n_1 - n_m}{n_m} \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$m \equiv \frac{h'}{h} = -\frac{s'}{s}$$

$$f = \frac{r}{2}$$

$$m = m_{\text{objective}} m_{\text{eyepiece}}$$

$$m \sim \left(\frac{N.P.}{f_e} \right) \left(\frac{\ell - f_e}{d_o} \right)$$

$$M = \frac{\theta_{\text{telescope}}}{\theta_{\text{naked eye}}} = -\frac{f_o}{f_e}$$

$$d \sin(\theta) = m\lambda$$

$$\text{where } m \in \{0, \pm 1, \pm 2, \dots\}$$

$$d \sin(\theta) = \left(m - \frac{1}{2} \right) \lambda$$

$$\text{where } m \in \{1, 2, \dots\}$$

$$y = L \frac{m\lambda}{d}$$

$$\sin(\theta) = 1.22 \frac{\lambda}{D}$$

$$E = \Delta mc^2$$

$$E_{\text{photon}} = hf = pc$$

$$E_{\text{photon}} = hf = \hbar\omega = \frac{hc}{\lambda}$$

$$\Delta r = 2d \cos \theta_m = m\lambda; m = 1, 2, 3, \dots$$

$$V_{\text{stop}} = \frac{K_{\text{max}}}{e}$$

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

$$r_n = \frac{n^2}{Z} a_B$$

$$n\lambda_n = \frac{nh}{m_e v_n} = 2\pi r_n$$

$$E_n = -\frac{Z^2}{n^2} (13.6 \text{ eV})$$

$$\frac{1}{\lambda} = \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right) \mathcal{R}$$

$$Q = (M_A + M_B - M_C - M_D)c^2$$

$$|\vec{L}| = m_e v r_n = n \frac{h}{2\pi} = n\hbar$$

$$v_n = \frac{nh}{2\pi m r_n} = \frac{2\pi k e^2}{nh}$$

$$r_n = \left(\frac{h^2}{4\pi^2 m k Z e^2} \right) n^2$$

$$N(t) = N_0 e^{-\lambda t} = N_0 2^{-t/t_{1/2}}$$

$$\lambda = \frac{\ln 2}{t_{1/2}}$$

$$R \equiv \frac{\Delta N}{\Delta t}$$

$$R = N\lambda = \frac{N \ln 2}{t_{1/2}}$$

$$r = r_{\text{nuc}} A^{1/3}$$

Hydrogen Spectrum Series

$$\text{Lyman: } n_f = 1$$

$$\text{Balmer: } n_f = 2$$

$$\text{Paschen: } n_f = 3$$