Final Exam Equations

Mechanics

$$\vec{F} = m\vec{a}$$

$$F_{centripetal} = m\frac{v^2}{R}$$

$$F_G = mg = \frac{Gm_1m_2}{r_{12}^2}$$

$$W = F_x\Delta x = \Delta KE + \Delta U$$

$$KE = \tfrac{1}{2}mv^2$$

$$PE = mgh$$

Kinematics

$$\Delta x = v_x\Delta t + \tfrac{1}{2}a_x\left(\Delta t\right)^2$$

$$\Delta x = \tfrac{1}{2}\left(v_f + v_0\right)\Delta t$$

$$v_f = v_{0x} + a_x\Delta t$$

$$v_{fx}^2 = v_{0x}^2 + 2a_x\Delta x$$

Circuits

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

$$V = IR$$

$$\sum V_{around\ loop} = 0$$

$$\sum I_{in} = \sum I_{out}$$

$$P = \frac{\Delta U_E}{\Delta t} = \frac{q\Delta V}{\Delta t}$$

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

$$R_{ser} = R_1 + R_2 \qquad \frac{1}{R_{\parallel}} = \frac{1}{R_1} + \frac{1}{R_2}$$

Electrostatics

$$F_E = qE = \frac{kQq}{r^2} \qquad E = \frac{F_E}{q} = \frac{kQ}{r^2}$$

$$\Delta V = \frac{\Delta U_E}{q} = -\frac{kQ}{r} \qquad \Delta V = -Ed$$

$$W = F_Ed = qEd = -\Delta U_E = -q\Delta V$$

$$\Delta U = -F_Er = -\frac{kQq}{r}$$

Magnetic Fields

$$\vec{F} = q\vec{v}\times\vec{B} \quad \Rightarrow \quad F = qvB\sin\theta$$

$$\vec{F} = I\vec{L}\times\vec{B} \quad \Rightarrow \quad F = ILB\sin\theta$$

$$v_{selected} = \frac{E}{B} \qquad v_{flow} = \frac{E}{B} = \frac{\Delta V / d}{B}$$

$$\tau_{loop} = NIAB\sin\theta$$

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

$$B_{loop} = \frac{\mu_0 NI}{2r} \qquad B_{solenoid} = \frac{\mu_0 NI}{L}$$

$$\Phi = AB_{\perp} = A_{\perp}B = AB\cos\theta$$

$$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t} \qquad \mathcal{E}_{motional} = vLB_{\perp}$$

$$\frac{\mathcal{E}_1}{\mathcal{E}_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$$

$$C_{\parallel} = C_1 + C_2 \qquad \frac{1}{C_{ser}} = \frac{1}{C_1} + \frac{1}{C_2}$$

Optics

$$v = \lambda f = \frac{c}{n} \qquad \theta_i = \theta_r \qquad n_i \sin\theta_i = n_t \sin\theta_t \qquad d\sin\theta = m\lambda$$

$$\lambda = \frac{\lambda_0}{n} = \frac{\lambda_{vacuum}}{n} \qquad \tan\theta_B = \left(\frac{n_t}{n_i}\right) \qquad \sin\theta_c = \left(\frac{n_t}{n_i}\right) \qquad d\sin\theta = \left(m + \frac{1}{2}\right)\lambda$$

$$a\sin\theta = m\lambda$$

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q} \qquad m = -\frac{q}{p} \qquad I = I_0 \cos^2\theta \qquad a\sin\Delta\theta \geq 1.22\lambda_0$$

Nuclear

$$E = mc^2 \qquad E_B = \Delta mc^2$$

$$\Delta m = m_{final} - m_{initia} = m_{parts} - m_{nucleus}$$

$$= \left(m_{protons} + m_{neutrons}\right) - m_{nucleus}$$

$$R = N\lambda = R_0 e^{-t\lambda} = R_0 e^{-t/\tau} = R_0 \left(\frac{1}{2}\right)^{t/T_{1/2}}$$

$$\tau = \frac{1}{\lambda} = \frac{T_{1/2}}{\ln 2}$$

$$N = N_0 e^{-t\lambda} = N_0 e^{-t/\tau} = N_0 \left(\frac{1}{2}\right)^{t/T_{1/2}} = N_0 \left(2\right)^{-t/T_{1/2}}$$

Dr. Jahncke's Equations

$$(m + \tfrac{1}{2})\lambda = (d_2 - d_1) + (\phi_2 - \phi_1)$$

$$m\lambda = (d_2 - d_1) + (\phi_2 - \phi_1)$$

$$(m + \tfrac{1}{2})\lambda_{film} = \left(\frac{2t}{\cos\theta}\right) + \Delta\phi$$

$$m\lambda_{film} = \left(\frac{2t}{\cos\theta}\right) + \Delta\phi$$

Atomic

$$r_n = n^2 a_0 = n^2 \left(\frac{\hbar^2}{m_e k e^2}\right) = 52.9 n^2 \text{ pm}$$

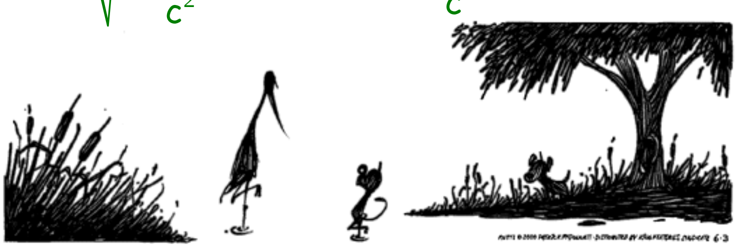
$$E_n = \frac{E_1}{n^2} = \frac{-13.6}{n^2} \text{ eV}$$

$$K = hf - \phi \qquad hf_{max} = K$$

Relativity

$$\Delta t = \gamma \Delta t_0 \qquad L = \frac{L_0}{\gamma}$$

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad v_{PA} = \frac{v_{PB} + v_{BA}}{1 + \frac{v_{PB} v_{BA}}{c^2}}$$



Constants to know and love:

- $k = 9 \times 10^{9}$ N-m^2/C^2
- $G = 6.67 \times 10^{-11}$ N-m^2/kg^2
- $e = 1.60 \times 10^{-19}$ C
- $m_e = 9.11 \times 10^{-31}$ kg
- $m_p = 1.67 \times 10^{-27}$ kg
- $c = 2.998 \times 10^{8}$ m/s
- $N_A = 6.02 \times 10^{23}$ things/mole
- $\epsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2
- $\mu_0 = 4\pi \times 10^{-7}$ T-m/A
- $m_n = 1.0086649$ u
- $m_p = 1.0072765$ u
- $m_e = 0.0005486$ u
- 1 u = 931.494 MeV/c^2
- 1 u = 1.6605×10^{-27} kg
- $c^2 = 931.494$ MeV/u
- 1 Ci = 3.7×10^{10} Bq
- $h = 6.626 \times 10^{-34}$ J-s
- $h = 4.136 \times 10^{-15}$ eV-s
- $\hbar = 1.055 \times 10^{-34}$ J-s
- $\hbar = 6.582 \times 10^{-16}$ eV-s
- hc = 1240 eV-nm
- 1 eV = 1.6×10^{-19} J