Formula Sheet for LSU Physics 2112, EXAM 3, Fall 2019

Units:

$1\,\text{m} = 39.4\,\text{in} = 3.28\,\text{ft}$ $\quad 1\,\text{mi} = 5280\,\text{ft}$ $\quad 1\,\text{min} = 60\,\text{s}$, $\quad 1\,\text{day} = 24\,\text{h}$ $\quad 1\,\text{rev} = 360° = 2\pi\,\text{rad}$

$1\,\text{atm} = 1.013{\times}10^5\,\text{Pa} = 760\ \text{torr} = 14.7\ \text{psi}$ $\quad T = \left(\frac{1\,K}{1°\text{C}}\right) T_\text{C} + 273.15\,\text{K}$ $\quad T_\text{F} = \left(\frac{9\,°\text{F}}{5°\text{C}}\right) T_\text{C} + 32°\text{F}$

$1\ \text{V} = \text{J/C}$ $\quad 1\ \text{eV}{=}1.602{\times}10^{-19}\ \text{J}$

Constants:

$\text{g} = 9.8\,\text{m/s}^2$ $\quad m_e = 9.109\times10^{-31}\,\text{kg}$ $\quad m_p = 1.673\times10^{-27}\,\text{kg}$

$m_e c^2 = 511\,\text{keV}$ $\quad m_p c^2 = 938\,\text{MeV}$

$\text{e} = 1.602{\times}10^{-19}\,\text{C}$ $\quad \epsilon_0 = 8.854\times10^{-12}\,\text{C}^2/(\text{N m}^2)$ $\quad hc = 1239.8\ \text{eV·nm}$

$k = 1.38\times10^{-23}\,\text{J/K}$ $\quad R = 8.31\,\text{J/(mol·K)}$ $\quad$ Avogadro's # $= 6.02\ {\times}10^{23}$ particles/mol

$h = 6.626\times10^{-34}\ \text{J·s} = 4.136{\times}10^{-15}\ \text{eV·s}$ $\quad \hbar = 1.054\times10^{-34}\ \text{J·s} = 6.582{\times}10^{-16}\ \text{eV·s}$

Electromagnetic Waves:

Plane waves propagating in the x-direction:

$$E = E_\text{m}\cos(kx \pm \omega t) \qquad B = B_\text{m}\cos(kx \pm \omega t) \qquad k = \frac{2\pi}{\lambda} \qquad \lambda = \frac{c}{f} = \frac{2\pi c}{\omega}$$

Poynting Vector, Energy Density:

$$\mathbf{S} = \frac{1}{\mu_0}\mathbf{E}\times\mathbf{B} \qquad S = \frac{1}{c\mu_0}E^2 \qquad u_E = u_B = \epsilon_0 E^2/2 = B^2/(2\mu_0)$$

Intensity, Energy Flux: $$I = S_\text{avg} = \frac{1}{2c\mu_0}E_m^2 = \frac{1}{c\mu_0}E_\text{rms}^2 \qquad I = \frac{P}{4\pi r^2}$$

Geometrical Optics and Images:

$$\text{Reflection}: \quad \theta_\text{r} = \theta_\text{i} \qquad \text{Snell's Law}: \quad n_1\sin\theta_1 = n_2\sin\theta_2$$

$$\frac{1}{p} + \frac{1}{i} = \frac{1}{f} \qquad f = r/2 \qquad m = -\frac{i}{p} \qquad m_\theta = -\frac{f_\text{ob}}{f_\text{ey}} \qquad M = m_1 m_2$$

Physical Optics:

$$n = \frac{c}{v} \qquad \lambda_n = \frac{\lambda}{n} \qquad f_n = \frac{c/n}{\lambda/n} = f \qquad \frac{\Delta\phi}{2\pi} = \Delta\left(\frac{L}{\lambda_n}\right) + \text{“other”} = \Delta N$$

$$\text{Two} - \text{Slit Interference}: \ \Delta L = d\sin\theta = m\lambda \qquad \Delta L = d\sin\theta = (m + \frac{1}{2})\lambda$$

$$I(\theta) = 4I_0\cos^2\beta = 4I_0\cos^2(\phi/2) = 4I_0\cos^2\left(\frac{\pi d}{\lambda}\sin\theta\right) \qquad I_\text{max} = 4I_0$$

Thin Films: $\Delta\phi = \pi$, reflecting off a higher n; $\quad \Delta\phi = 0$, reflecting off a lower n

$$2L + \text{“other”} = m\lambda_n \qquad 2L + \text{“other”} = (m + \frac{1}{2})\lambda_n$$

Diffraction through a rectangular slit and a circular aperture:

$$\text{One} - \text{Slit Minima}: \quad a\sin\theta = m\lambda \qquad \text{Rayleigh's Criterion}: \quad \theta_\text{R} = 1.22\frac{\lambda}{d}$$

$$I(\theta) = I_m\left(\frac{\sin\alpha}{\alpha}\right)^2 \qquad \alpha = \frac{\pi a}{\lambda}\sin\theta$$

Two-Slit Interference and Diffraction:

$$I(\theta) = I_m\cos^2\beta\left(\frac{\sin\alpha}{\alpha}\right)^2 \qquad \beta = \phi/2 = \frac{\pi d}{\lambda}\sin\theta \quad \alpha = \frac{\pi a}{\lambda}\sin\theta$$

Diffraction Gratings:

$$d\sin\theta = m\lambda \qquad \text{Dispersion}: \quad D = \frac{\Delta\theta}{\Delta\lambda} = \frac{m}{d\cos\theta} \qquad \text{Resolving Power}: \quad R = \frac{\lambda_\text{avg}}{\Delta\lambda} = Nm$$