

Physics 1214, Formula sheet for Midterm III

Electromagnetic waves

Plane wave: $E_y = E_{max} \sin(\omega t - kx)$, $B_z = B_{max} \sin(\omega t - kx)$

$$E_{max} = cB_{max}, c = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$$

Energy density in EM wave: $u = \frac{\epsilon_0 E^2}{2} = \frac{B^2}{2\mu_0}$

Wave number k , wavelength λ , frequency f , angular frequency ω , speed c :

$$k = \frac{2\pi}{\lambda} \quad f = \frac{\omega}{2\pi} \quad c = \frac{\omega}{k} = \lambda f$$

Geometric optics

Reflection: $\theta_r = \theta_a$

Refraction: $n_a \sin \theta_a = n_b \sin \theta_b$

Total internal reflection: $\sin \theta_{crit} = \frac{n_a}{n_b}$

Spherical mirror: $\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$ $f = \frac{R}{2}$ $m = -\frac{s'}{s}$

Thin lens: $\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$ $\frac{1}{f} = (n-1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$ $m = -\frac{s'}{s}$

Compound lenses: $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

Refraction at a sphere: $\frac{n_a}{s} + \frac{n_b}{s'} = \frac{n_b - n_a}{R}$ $m = -\frac{n_a s'}{n_b s}$

Lateral displacement of a ray going through a plate of thickness h : $d = h \frac{\sin(\theta_a - \theta_b)}{\cos \theta_b}$

Optical instruments

Angular magnification of a magnifying lens: $M = \frac{25 \text{ cm}}{f}$

Microscope: $M = \frac{s'_1}{f_1} \frac{25 \text{ cm}}{f_2}$

Telescope: $M = -\frac{f_1}{f_2}$

Useful constants:

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/(\text{N} \cdot \text{m}^2)$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ T} \cdot \text{m}/\text{A}$$

$$c = 3 \times 10^8 \text{ m/s}$$