PHYSICS 232 – TEST # 2

NAME:

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USEFUL FORMULAS

Electromagnetic waves

$$E = cB \quad , \quad c = \frac{1}{\sqrt{\epsilon_o \mu_o}}$$

$\epsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{Nm^2}$, $c = 3 \times 10^8$ m/s.
Poynting vector (power per unit area):

$$\vec{S} = \frac{1}{\mu_o} \vec{E} \times \vec{B}$$

Intensity: $I = \langle S \rangle = \frac{1}{2} \epsilon_o c E_{max}^2$.
Rate of transfer of momentum per area:

$$\frac{1}{A} \frac{dp}{dt} = \frac{S}{c}$$

Radiation pressure:

$$p_{rad} = I/c \quad \text{(absorbing surface)}$$

$$p_{rad} = 2I/c \quad \text{(reflecting surface)}$$

Light

Speed of light in material: $v = \frac{c}{n}$.
Snell's Law (refraction):

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

Total internal reflection for $\theta > \theta_{crit}$:

$$\sin \theta_{crit} = \frac{n_a}{n_b}$$

Malus's Law (intensity through polarizer):

$$I = I_{max} \cos^2 \phi,$$

Complete polarization $\perp$ to plane of incidence:

$$\tan \theta_p = \frac{n_b}{n_a}$$

Geometric optics

Spherical mirror:

$$\frac{1}{s} + \frac{1}{s'} = \frac{2}{R} = \frac{1}{f}$$

Lateral magnification: $m = -\frac{s'}{s}$.
Spherical mirror refracting surface:

$$\frac{n_a}{s} + \frac{n_b}{s'} = \frac{n_b - n_a}{R}$$

Lateral magnification: $m = -\frac{n_a s'}{n_b s}$.
Lens:

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

Interference and diffraction

Thin film: $2t = m\lambda$.
Two sources:

$$I = I_0 \cos^2(\pi d \sin \theta / \lambda)$$

Maxima ($I = I_0$) at

$$d \sin \theta = m\lambda \quad (m = \ldots, -2, -1, 0, 1, 2, \ldots)$$

N-source interference:

$$I = I_0 \frac{\sin^2(N\pi d \sin \theta / \lambda)}{\sin^2(\pi d \sin \theta / \lambda)}$$

Principal maxima ($I = N^2 I_0$) at

$$d \sin \theta = m\lambda \quad (m = \ldots, -2, -1, 0, 1, 2, \ldots)$$

Intensity from single aperture of width a:

$$I = I_0 \frac{\sin^2(\pi a \sin \theta / \lambda)}{(\pi a \sin \theta / \lambda)^2}$$

Minima at

$$a \sin \theta = m\lambda \quad (m = \ldots, -2, -1, 1, 2, \ldots)$$

Bragg condition: $2d \sin \theta = m\lambda$.
Rayleigh's criterion:

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