PHYSICS 2P51 Formulae

Constants

$c = 2.998 \times 10^8$ m/s e $= 1.602 \times 10^{-19}$ C h$= 6.64 \times 10^{-34}$ Js
$\epsilon_o = 8.85 \times 10^{-12}$ F/m $\sigma = 5.67 \times 10^{-8}$ W/(m^{2}K^4) k $= 1.38 \times 10^{-23}$ J/K
1 eV $= 1.602 \times 10^{-19}$ J hc $= 1239$ eV-nm $\mu_o = 4\pi \times 10^{-7}$ Tm/A

Wave-Particle Duality

$I = Nhf$ $E = hf$ $E = hc/\lambda$
$p = h/\lambda$ $hf = K_{max} + W = eV_s + W$ $I = 1/2(c\epsilon_o E^2)$

Sources and Detectors

$M(\lambda) = \frac{2\pi hc^2}{\lambda^5} \frac{1}{e^{hc/\lambda kT}+1}$
$\lambda_{max} T = 2.998 \times 10^6$ nm-K
$\int_o^\infty M(\lambda) d\lambda = \sigma T^4$
$E = \frac{-13.6}{n^2}$ eV
$\frac{N_1}{N_2} = e^{-\Delta E/kT}$
$V_o = V \frac{R_o}{R_1 + R_o}$
$R = \rho L/A$
$\rho = m^*/ne^2\tau$

Wave Properties

$\frac{\partial^2 f}{\partial x^2} = \frac{1}{v^2} \frac{\partial^2 f}{\partial t^2}$
$f(x,t) = f(x \pm vt)$

$E = E_o \sin(kz - \omega t)$
$E(z=0) = E_o \sin(\omega t) = Im(E_o e^{i\omega t})$
$E = cB$

$\omega = 2\pi f$ $k = \frac{2\pi}{\lambda}$ $I = \frac{1}{2} c\epsilon_o E^2$

$d \sin\theta = n\lambda$ $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos(\delta)$ $\delta = \frac{2\pi}{\lambda} \cdot \Delta L$

$v = \frac{c}{n}$ $\delta = 2nt$ $R = \frac{(n_2 - n_1)^2}{(n_2 + n_1)^2}$

$C = V = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}$ $\Delta S = N\lambda = c\Delta t$ $S \sin(w) << \frac{1}{2}\lambda$

$I = I_o (\frac{\sin\alpha}{\alpha})^2 \cos^2(\beta)$ where $\alpha = \pi \frac{a \sin\theta}{\lambda}$ and $\beta = \pi \frac{d \sin\theta}{\lambda}$

$a \sin\theta = m\lambda$ $\theta_{min} \approx 1.22 \frac{\lambda}{D}$

$I = I_o \frac{\sin^2(N \frac{\pi}{\lambda} d \sin\theta)}{\sin^2(\frac{\pi}{\lambda} d \sin\theta)}$ $d \sin\theta = m\lambda$ $\frac{\lambda}{\Delta\lambda} = Nm$

$I = I_o \cos^2(\theta)$ $\tan\theta_B = \frac{n_2}{n_1}$ $\Delta\phi = 2\pi \frac{(n_\perp - n_\parallel)L}{\lambda}$

Geometrical Optics

$\sin u = u - \frac{u^3}{3!} + \frac{u^5}{5!} - \cdots$

$u \approx \sin u \approx \tan u \quad \text{for } u << 1$

$n \sin I = n' \sin I'$

$\frac{n_{prism}}{n_o} = \frac{\sin \frac{1}{2}(A+D)}{\sin \frac{1}{2}A}$

$P = \frac{n'-n}{R} \qquad P = (n-1)(\frac{1}{R_1} - \frac{1}{R_2}) = 1/f$

$\frac{1}{s} + \frac{1}{f} = \frac{1}{s'} \qquad M_T = s'/s \qquad M_x = |s_1' - s_2'|/|s_1 - s_2| \qquad M_x = M_T^2$

$P_{eq} = P_1 + P_2 - P_1 P_2 d/n$

$f = -R/2$

$V = n/R \qquad V_2 = \frac{V_1}{1 - V_1(d/n)} \qquad P_{BV} = \frac{P_1}{1 - P_1(d/n)} + P_2$

$R = \begin{pmatrix} 1 & P \\ 0 & 1 \end{pmatrix} \quad T = \begin{pmatrix} 1 & 0 \\ -d/n & 1 \end{pmatrix} \quad F = \begin{pmatrix} 1 & -2n/R \\ 0 & 1 \end{pmatrix} \quad \begin{pmatrix} nu \\ h \end{pmatrix}$

$S = \begin{pmatrix} b & a \\ d & c \end{pmatrix}$, n_1: medium before S, n_3: medium after S.

$P_{eq} = a \qquad f_1 = -\frac{n_1}{a} \qquad f_2 = \frac{n_3}{a} \qquad f_{FV} = -\frac{bn_1}{a} \qquad f_{BV} = \frac{cn_3}{a}$

$V = \frac{n_e - 1}{n_{F'} - n_{C'}}$

$d = \frac{1}{2}(f_1 + f_2)$ or $P_A = P_{eq}\left(\frac{V_A}{V_A - V_B}\right)$ and $P_B = -P_{eq}\left(\frac{V_B}{V_A - V_B}\right)$