Physics 203 Formula Sheet - Optics

Index of refraction $n = \frac{c}{v}$ $\lambda = \frac{\lambda_o}{n}$ $f = f_o$ $E = E_o$

Snell's Law $n_1 \sin\theta_1 = n_2 \sin\theta_2$

Total internal reflection $\sin\theta_{crit} = \frac{n_2}{n_1}$ where $n_2 < n_1$ coming from material 1

Malus' Law for polarized light $I = I_{max} \cos^2\theta$

Brewster's angle $\tan\theta_p = \frac{n_2}{n_1}$ coming from material 1

object-image for a spherical mirror $\frac{1}{s} + \frac{1}{s'} = \frac{2}{R} = \frac{1}{f}$ lateral magnification $m = \frac{y'}{y} = -\frac{s'}{s}$

lensmakers equation for a thin lens $\frac{1}{s} + \frac{1}{s'} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = \frac{1}{f}$

camera lens f-number $= \frac{\text{focal length}}{\text{aperature diameter}} = \frac{f}{D}$, camera stops increase exposure by X2

nearsighted means image for far object in front of retina; farsighted image behind retina

magnifier angular magnification $M = \frac{\theta_{observed}}{\theta_{actual}} \cong \frac{25\text{ cm}}{f}$

microscope overall magnification $= m_{objective} M_{eyepiece} \cong \frac{(25\text{ cm})s_o'}{f_{obj} f_{eye}}$

terrestrial telescope angular magnification $M = -\frac{f_{obj}}{f_{eye}}$

condition for <u>constructive</u> interference for two, distant, coherent sources a distance d apart

$d\sin\theta = m\lambda \quad m = 0, \pm 1, \pm 2, \ldots$

condition for destructive interference $\left(m + \frac{1}{2}\right)\lambda = d\sin\theta \quad m = 0, \pm 1, \pm 2, \ldots$

two source interference $I = I_o \cos^2\left(\frac{\phi}{2}\right)$

reflection from higher index material cause a 180° phase shift; lower index material no phase shift

energy of a photon $E = hf = \frac{hc}{\lambda}$

condition for <u>destructive</u> interference diffraction for a single slit, $a\sin\theta = m\lambda \quad m = 0, \pm 1, \pm 2, \ldots$

where intensity is $I = I_o \left\{ \frac{\sin\left[\frac{\pi a(\sin\theta)}{\lambda}\right]}{\frac{\pi a(\sin\theta)}{\lambda}} \right\}^2$

diffraction grating with spacing d, constructive interference occurs when $d\sin\theta = m\lambda, \; m = 0, \pm 1, \pm 2, \ldots$

periodic crystal with plane spacing d, constructive interference occurs when $d\sin\theta = m\lambda \quad m = 0, \pm 1, \pm 2, \ldots$

for a circular aperture of diameter D the first dark ring occurs at $\sin\theta = 1.22\frac{\lambda}{D}$