# **Formula Final Exam** - PH106

## Electromagnetic Waves

$\oint Bdl = \mu_0 I + \mu_0 \epsilon_0 \frac{d\Phi(E)}{dt}$
$c = \frac{|E|}{|B|} = \frac{E_{max}}{B_{max}} = \frac{1}{\sqrt{\mu_0 \epsilon_0}} = \lambda f$
$E(x,t) = E_{max} \sin(kx - \omega t) \qquad B(x,t) = B_{max} \sin(kx - \omega t) \qquad k = 2\pi/\lambda \qquad \omega = 2\pi f$
$\vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B} \qquad I =< S >= \frac{E_{max} B_{max}}{2\mu_0} \qquad I = \frac{Power}{Area} \qquad Area_{S^2} = 4\pi r^2$
$|\Delta \vec{p}| = \frac{U}{c} \qquad P_r = \frac{I}{c} \qquad$ Ab.
$|\Delta \vec{p}| = 2\frac{U}{c} \qquad P_r = 2\frac{I}{c} \qquad$ Ref.

## Reflection and Refraction

$n \equiv \frac{c}{v} = \frac{\lambda_0}{\lambda_n}$
$\theta_1' = \theta_1$
$n_1 \sin\theta_1 = n_2 \sin\theta_2 \qquad \sin\theta_c = \frac{n_2}{n_1} \quad (n_1 > n_2)$

## Mirrors and Lenses

$M = \frac{h'}{h} = -\frac{q}{p}$
$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$
$f = \frac{R}{2} \qquad \frac{1}{f} = (n-1)(\frac{1}{R_1} - \frac{1}{R_2})$

Sign conventions for mirrors:

| quantity | symbol | in front | in back | concave | convex |
|---|---|---|---|---|---|
| objet location | p | + | - | | |
| image location | q | + | - | | |
| focal length | f | | | + | - |

Sign conventions for thin lenses

| quantity | symbol | in front | in back | convergent | divergent |
|---|---|---|---|---|---|
| objet location | p | + | - | | |
| image location | q | - | + | | |
| lens radii | $R_1, R_2$ | - | + | | |
| focal length | f | | | + | - |

$h' > 0$: virtual; $h' < 0$: real

## Waves Optics

$d\sin\theta_B = m\lambda \quad m = 0, \pm1, \pm2, ... \qquad d\sin\theta_D = (m + 1/2)\lambda \quad m = 0, \pm1, \pm2, ...$ (interference)
$a\sin\theta_D = m\lambda \quad m = \pm1, \pm2, ...$ (diffraction)
$d\sin\theta_B = m\lambda \quad m = 0, \pm1, \pm2, ...$ (diffraction grating)
$\sin\theta \simeq \tan\theta = \frac{y}{L}$
$I = I_0 \cos^2\theta$