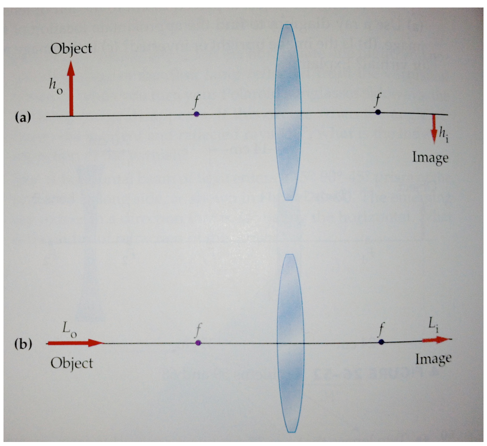
Name________________________________________

Physics 111 Quiz #6, March 1, 2013

*Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.*

*I affirm that I have carried out my academic endeavors with full academic honesty.* ________________

1. An object $2cm$ long is located near a converging lens ( $f_c = 30cm$ )as shown in the figure below. The lateral magnification is defined as the image height to the object height ( $\frac{h_i}{h_o}$ ) as would be calculated in figure (a). Consider figure (b) instead where the object lies along the principle axis, extending from $74cm$ to $76cm$ from the lens. What is the longitudinal magnification, defined as $\frac{L_i}{L_o}$?




$$\frac{1}{d_{o,R}} + \frac{1}{d_{i,R}} = \frac{1}{f_c} \rightarrow \frac{1}{74cm} + \frac{1}{d_{i,R}} = \frac{1}{30cm} \rightarrow d_{i,R} = 50.5cm$$

$$\frac{1}{d_{o,L}} + \frac{1}{d_{i,L}} = \frac{1}{f_c} \rightarrow \frac{1}{76cm} + \frac{1}{d_{i,L}} = \frac{1}{30cm} \rightarrow d_{i,L} = 49.6cm$$

$$M_{longitudinal} = \frac{L_i}{L_o} = \frac{(50.5 - 49.6)cm}{(76 - 74)cm} = 0.45$$

2. Suppose that a double convex lens is used to produce a real image. What happens to the image if the lens is covered with an opaque substance everywhere except for a small circular spot near the bottom of the lens? (Opaque means that light will not be transmitted through this region of the lens.)

   a. A portion of the image disappears that depends on how you look through the lens.

   b. The entire image is visible but dimmer.

   c. The image completely disappears

   d. Nothing happens to the image.

3. Two slits with a separation of $8.5 \times 10^{-5} m$ create an interference pattern on a screen $2.3m$ away. If the tenth constructive interference is $12cm$ what wavelength of light was used in the experiment?

$$d \sin\theta_m = d \tan\theta_m = d\left(\frac{y_m}{D}\right) = m\lambda$$

$$\rightarrow \lambda = \frac{d \cdot y_m}{m \cdot D} = \frac{8.5 \times 10^{-5} m \times 0.12m}{10 \times 2.3m} = 4.43 \times 10^{-7} m = 443nm$$

4. Suppose that in the experiment above, you used the same experimental parameters, except this time you did the experiment under water ($n_{water} = 1.33$). Which quantity (or quantities) will change?

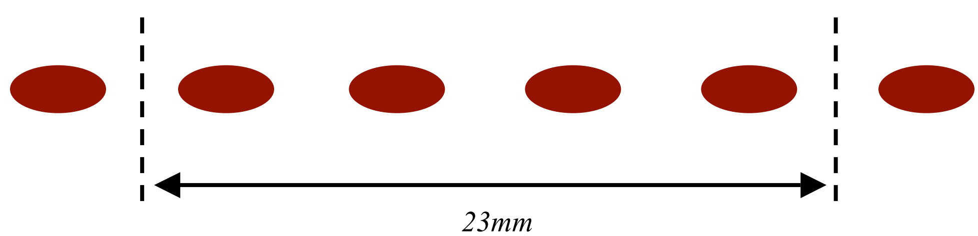
a. Only $\lambda$ will change.

b. Only $\Delta y_{\text{constructive}}$ (the distance between adjacent interference maxima) will change.

c. $\lambda$ and $\Delta y_{\text{constructive}}$ (the distance between adjacent interference maxima) will change.

d. $\lambda$, $\Delta y_{\text{constructive}}$ (the distance between adjacent constructive interference maxima) and $\Delta y_{\text{destructive}}$ (the distance between adjacent destructive interference minima) will change.

5. Light from a laser ($\lambda = 633nm$) strikes a pair of slits forming the interference pattern shown below on a screen $1.4m$ from the slits. What is the slit separation?




$$d \sin\theta_m = d \tan\theta_m = d\left(\frac{y_m}{D}\right) = m\lambda$$

$$\rightarrow d = \frac{\lambda \cdot m \cdot D}{y_m} = \frac{633 \times 10^{-9} m \times 4 \times 1.4m}{0.023m} = 1.54 \times 10^{-4} m = 154 \mu m$$

# Physics 111 Equation Sheet

## Electric Forces, Fields and Potentials

$$\vec{F} = k\frac{Q_1Q_2}{r^2}\hat{r}$$

$$\vec{E} = \frac{\vec{F}}{q}$$

$$\vec{E}_Q = k\frac{Q}{r^2}\hat{r}$$

$$PE = k\frac{Q_1Q_2}{r}$$

$$V(r) = k\frac{Q}{r}$$

$$E_x = -\frac{\Delta V}{\Delta x}$$

$$W_{f,i} = -q\Delta V_{f,i}$$

## Magnetic Forces and Fields

$$F = qvB\sin\theta$$

$$F = IlB\sin\theta$$

$$\tau = NIAB\sin\theta = \mu B\sin\theta$$

$$PE = -\mu B\cos\theta$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$\varepsilon_{induced} = -N\frac{\Delta\phi_B}{\Delta t} = -N\frac{\Delta(BA\cos\theta)}{\Delta t}$$

## Constants

$g = 9.8\frac{m}{s^2}$

$1e = 1.6\times10^{-19}C$

$k = \frac{1}{4\pi\varepsilon_o} = 9\times10^9\frac{C^2}{Nm^2}$

$\varepsilon_o = 8.85\times10^{-12}\frac{Nm^2}{C^2}$

$1eV = 1.6\times10^{-19}J$

$\mu_o = 4\pi\times10^{-7}\frac{Tm}{A}$

$c = 3\times10^8\frac{m}{s}$

$h = 6.63\times10^{-34}Js$

$m_e = 9.11\times10^{-31}kg = \frac{0.511MeV}{c^2}$

$m_p = 1.67\times10^{-27}kg = \frac{937.1MeV}{c^2}$

$m_n = 1.69\times10^{-27}kg = \frac{948.3MeV}{c^2}$

$1amu = 1.66\times10^{-27}kg = \frac{931.5MeV}{c^2}$

$N_A = 6.02\times10^{23}$

$Ax^2 + Bx + C = 0 \rightarrow x = \frac{-B\pm\sqrt{B^2-4AC}}{2A}$

## Electric Circuits

$$I = \frac{\Delta Q}{\Delta t}$$

$$V = IR = I\left(\frac{\rho L}{A}\right)$$

$$R_{series} = \sum_{i=1}^{N} R_i$$

$$\frac{1}{R_{parallel}} = \sum_{i=1}^{N}\frac{1}{R_i}$$

$$P = IV = I^2R = \frac{V^2}{R}$$

$$Q = CV = \left(\frac{\kappa\varepsilon_0 A}{d}\right)V = (\kappa C_0)V$$

$$PE = \tfrac{1}{2}QV = \tfrac{1}{2}CV^2 = \frac{Q^2}{2C}$$

$$Q_{\text{charge}}(t) = Q_{\max}\left(1 - e^{-\frac{t}{RC}}\right)$$

$$Q_{\text{discharge}}(t) = Q_{\max}e^{-\frac{t}{RC}}$$

$$C_{parallel} = \sum_{i=1}^{N} C_i$$

$$\frac{1}{C_{series}} = \sum_{i=1}^{N}\frac{1}{C_i}$$

## Light as a Wave

$$c = f\lambda = \frac{1}{\sqrt{\varepsilon_o\mu_o}}$$

$$S(t) = \frac{energy}{time\times area} = c\varepsilon_o E^2(t) = c\frac{B^2(t)}{\mu_0}$$

$$I = S_{avg} = \tfrac{1}{2}c\varepsilon_o E_{\max}^2 = c\frac{B_{\max}^2}{2\mu_0}$$

$$P = \frac{S}{c} = \frac{Force}{Area}$$

$$S = S_o\cos^2\theta$$

$$v = \frac{1}{\sqrt{\varepsilon\mu}} = \frac{c}{n}$$

$$\theta_{inc} = \theta_{refl}$$

$$n_1\sin\theta_1 = n_2\sin\theta_2$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

$$M_{total} = \prod_{i=1}^{N} M_i$$

$$d\sin\theta = m\lambda \text{ or } \left(m+\tfrac{1}{2}\right)\lambda$$

$$a\sin\phi = m'\lambda$$

## Light as a Particle & Relativity

$$E = hf = \frac{hc}{\lambda} = pc$$

$$KE_{\max} = hf - \phi = eV_{stop}$$

$$\Delta\lambda = \frac{h}{m_e c}(1-\cos\phi)$$

$$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$p = \gamma mv$$

$$E_{total} = KE + E_{rest} = \gamma mc^2$$

$$E_{total}^2 = p^2c^2 + m^2c^4$$

$$E_{rest} = mc^2$$

$$KE = (\gamma - 1)mc^2$$

## Nuclear Physics

$$E_{binding} = (Zm_p + Nm_n - m_{rest})c^2$$

$$\frac{\Delta N}{\Delta t} = -\lambda N_o \rightarrow N(t) = N_o e^{-\lambda t}$$

$$A(t) = A_o e^{-\lambda t}$$

$$m(t) = m_o e^{-\lambda t}$$

$$t_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$$

## Misc. Physics 110 Formulae

$$\vec{F} = \frac{\Delta\vec{p}}{\Delta t} = \frac{\Delta(mv)}{\Delta t} = m\vec{a}$$

$$\vec{F} = -k\vec{y}$$

$$\vec{F}_C = m\frac{v^2}{R}\hat{r}$$

$$W = \Delta KE = \tfrac{1}{2}m\left(v_f^2 - v_i^2\right) = -\Delta PE$$

$$PE_{gravity} = mgy$$

$$PE_{spring} = \tfrac{1}{2}ky^2$$

## Geometry

$Circles: \quad C = 2\pi r = \pi D \qquad A = \pi r^2$

$Triangles: \quad A = \tfrac{1}{2}bh$

$Spheres: \quad A = 4\pi r^2 \qquad V = \tfrac{4}{3}\pi r^3$