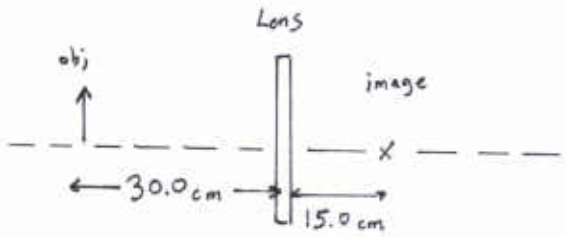
Name_____ Units? Units?

Phys 2020, Section 1
Quiz #5 — Spring 2002

1. An object of height 2.50 cm is placed 30.0 cm in front of a lens; its image appears 15.0 cm behind the lens (that is, on the opposite side).



a) What is the focal length of the lens?

Using our sign conventions,

$d_o = +30.0$ cm, $d_i = +15.0$ cm. Then:

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{30.0\,\text{cm}} + \frac{1}{15.0\,\text{cm}} = 0.100\ \text{cm}^{-1} \Rightarrow \boxed{f = 10.0\ \text{cm}}$$

b) Is the lens convex (bulges outward) or concave?

f is positive, so the lens is "converging", with a convex shape.

c) What is the height of the image?

The magnification is

$$m = -\frac{d_i}{d_o} = -\frac{(15.0\ \text{cm})}{(30.0\ \text{cm})} = -0.500$$ Then:

$$h_i = h_o m = (2.50\ \text{cm})(-0.500) = \boxed{-1.25\ \text{cm}}$$

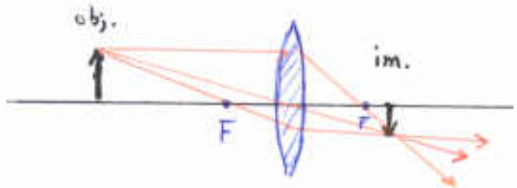
(I.e. image is inverted with absolute size 1.25 cm)

d) Is the image Upright or Inverted? Real or Virtual?

Since $m < 0$ (negative), the image is Inverted

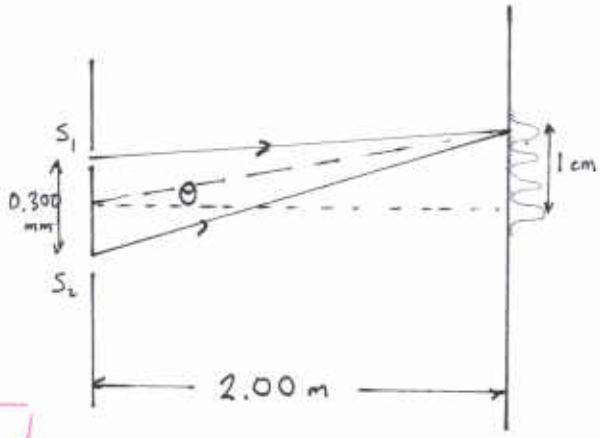
Since the rays really do focus to and emerge from a real point (i.e. $d_i > 0$)

the image is Real



2. A double–slit interference experiment is shown here. The slits are separated by 0.300 mm and the screen is 2.00 m from the slits.

The third–order (i.e. third away from the center) bright fringe falls a distance of 1.00 cm from the center of the pattern.



a) What is $\sin\theta$?

Using small angle approx,

$$\sin\theta \approx \tan\theta = \frac{0.0100\ \text{m}}{2.00\ \text{m}} = \boxed{5.00\times10^{-3}}$$

b) What is the wavelength of the light used?

Since $\sin\theta = m\lambda/d$, with $m = 3$ and $d = 0.300\ \text{mm} = 3.00\times10^{-4}\ \text{m}$, we get:

$$\lambda = \frac{d\sin\theta}{m} = \frac{(3.00\times10^{-4}\ \text{m})(5.00\times10^{-3})}{3} = 5.00\times10^{-7}\ \text{m} = \boxed{500.\ \text{nm}}$$

3. What is the energy of a photon whose wavelength is 1200 nm?

Use: $E = hf = h\frac{c}{\lambda}$, with $\lambda = 1200\ \text{nm} = 1.200\times10^{-6}\ \text{m}$

Then

$$E = (6.626\times10^{-34}\ \text{J}\cdot\text{s})\frac{(2.998\times10^{8}\ \frac{\text{m}}{\text{s}})}{(1.200\times10^{-6}\ \text{m})} = \boxed{1.66\times10^{-19}\ \text{J}}$$

You must show all your work and include the right units with your answers!

$1\ \text{nm} = 10^{-9}\ \text{m}$ $\quad 1\ \text{mm} = 10^{-3}\ \text{m}$ $\quad \frac{1}{d_o}+\frac{1}{d_i}=\frac{1}{f}$ $\quad m=\frac{h_i}{h}=-\frac{d_i}{d_o}$

$\sin\theta_{\text{br}} = m\frac{\lambda}{d}$ $\quad \sin\theta_{\text{dark}} = \left(m+\frac{1}{2}\right)\frac{\lambda}{d}$ $\quad \sin\theta_{\text{dark}} = m\frac{\lambda}{w}$

$c = 2.998\times10^{8}\frac{\text{m}}{\text{s}}$ $\quad h = 6.626\times10^{-34}\ \text{J}\cdot\text{s}$ $\quad \lambda f = c$ $\quad E = hf$ $\quad p = \frac{h}{\lambda}$

Small angle approx

$\sin\theta \approx \tan\theta \approx \theta$, in rad