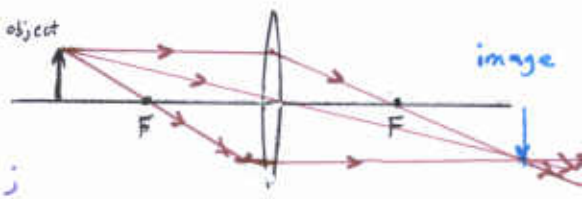
Units? Units?

Name_____

Phys 2020

Quiz #5 — Fall 2002

1. At the right is shown a convex lens with its focal points indicated an an object (on the left side of the lens).



By tracing rays, find the location and orientation of the image formed by the lens.

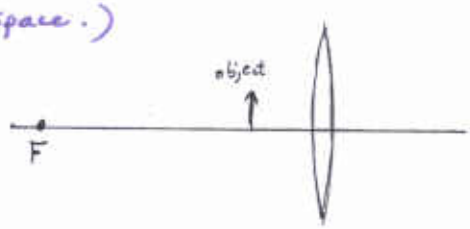
Rays are traced using parallel lines & focal points; ray thru center of lens also shown. Image is to the right of the lens, upside-down!

b) Is the image real or virtual? Upright or inverted?

Image is real. (Rays emerge from a true point in space.)

Image is inverted.

2. An object is located 4.0 cm in front of a convex lens of focal length 20.0 cm.



a) Where is the image located? (Give a distance and be clear about which side of the lens it is on.)

From the lens eqn, $\frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{f}$, with $d_o = +4.0\text{ cm}$, $f = +20.0\text{ cm}$, get:

$$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} = \frac{1}{(20.0\text{ cm})} - \frac{1}{(4.0\text{ cm})} = -2.0 \times 10^{-1}\text{ cm}^{-1}$$

$d_i = -5.0\text{ cm}$

Image is 5.0 cm from lens, on the left side (same as the object).

b) What is the magnification?

$$m = -\frac{d_i}{d_o} = -\frac{(-5.0\text{ cm})}{(4.0\text{ cm})} = 1.25$$

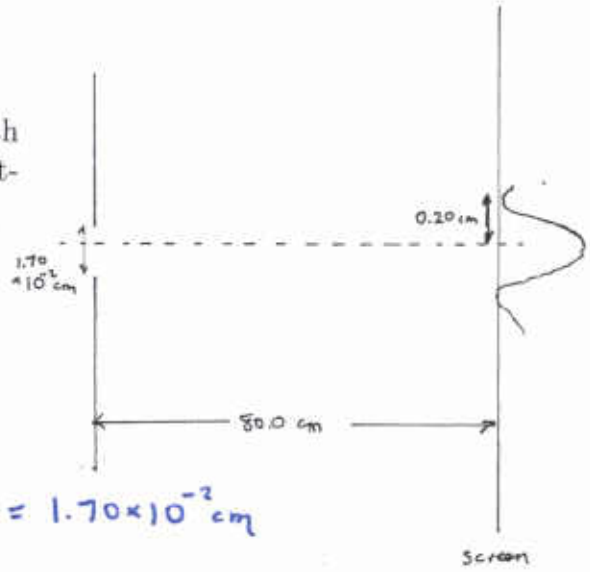
c) Is the image real or virtual? Upright or inverted?

Image is virtual. (since "source" of rays is on left side).

Image is upright (since $m > 0$)

3. Monochromatic light passes through a single slit of width 1.70×10^{-2} cm and falls on a screen 80.0 cm away. The first-order dark band is 0.20 cm from the center of the pattern.

What is the wavelength of the light?



Angle at which first dark fringe occurs:

$\tan\theta = \frac{(0.20\ \text{cm})}{(80.0\ \text{cm})} = 2.50 \times 10^{-3}$

$\theta = 0.143°$

$\sin\theta = 2.50 \times 10^{-3} = 1 \cdot \frac{\lambda}{w}$, where $w = 1.70 \times 10^{-2}$ cm

Solve for λ:

$\lambda = w(2.50 \times 10^{-3}) = (1.70 \times 10^{-2}\ \text{cm})(2.50 \times 10^{-3}) = 4.25 \times 10^{-5}$ cm

$= \boxed{4.25 \times 10^{-7}\ \text{m} = 425\ \text{nm}}$

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

$$\frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{f} \qquad m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

$$\sin\theta_{\text{br}} = m\frac{\lambda}{d} \qquad \sin\theta_{\text{dark}} = \left(m + \tfrac{1}{2}\right)\frac{\lambda}{d} \qquad m = 0, 1, 2, 3, \ldots$$

$$\sin\theta_{\text{dark}} = m\frac{\lambda}{w} \qquad m = 1, 2, 3, \ldots \qquad \sin\theta_{\text{min}} = (1.22)\frac{\lambda}{D}$$

Small-angle approx: $\theta(\text{rad}) \approx \sin\theta \approx \tan\theta$