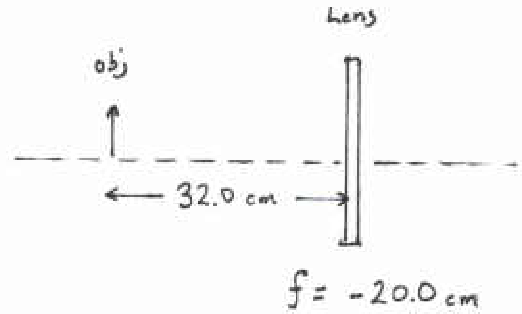
Name ____________ Units? Units?

Phys 2020, Section 2
Quiz #5 — Spring 2002



1. An object of height 2.0 cm is placed 32.0 cm in front of a lens of focal length −20.0 cm.

a) What is the location of the image? In you answer, state explicitly which side of the lens the image is on.

Using $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$, with $d_o = +32.0$ cm and $f = -20.0$ cm, get:

$$\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} = \frac{1}{(-20.0 \text{ cm})} - \frac{1}{(32.0 \text{ cm})} = -8.12 \times 10^{-2} \text{ cm}^{-1}$$

So: $d_i = \boxed{-12.3 \text{ cm}}$ The image is on the $\boxed{\text{left side}}$ of the lens (from $d_i < 0$) at a distance of $\boxed{12.3 \text{ cm}}$

b) What is the height of the image?

The magnification is

$$m = -\frac{d_i}{d_o} = -\frac{(-12.3 \text{ cm})}{(32.0 \text{ cm})} = 0.385$$

Then:

$$h_i = h_o m = (2.0 \text{ cm})(0.385) = \boxed{0.77 \text{ cm}}$$

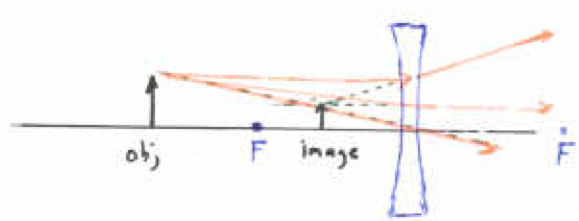
c) Is the lens convex (bulges outward) or concave?

Since $f < 0$, it is a diverging lens with a $\boxed{\text{concave}}$ shape.

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

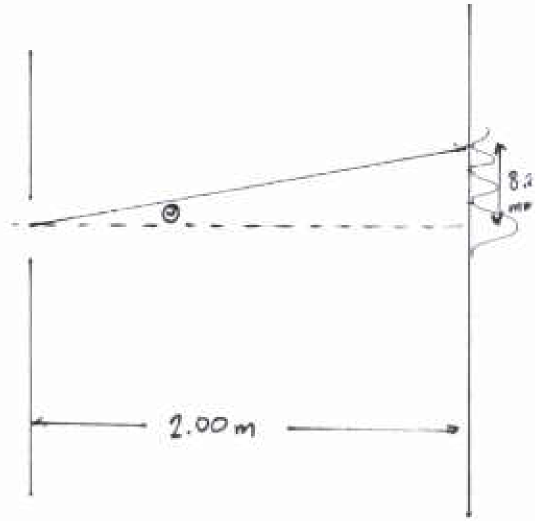
Since $m > 0$, the image is $\boxed{\text{Upright}}$

Since the rays "from" the image don't really diverge from a point (from $d_i < 0$) then the image is $\boxed{\text{Virtual}}$



2. Light of wavelength 640 nm illuminates a single (finite-width) slit. The screen is 2.00 m from the slit.

The third minimum in the diffraction pattern falls a distance 8.2 mm from the center of the pattern.



a) What is $\sin\theta$ for the third minimum?

$$\sin\theta \approx \tan\theta = \frac{(8.3\times10^{-3}\,m)}{(2.00\,m)}$$

$$= \boxed{4.15\times10^{-3}}$$

b) What is the width of the slit?

Use $\sin\theta = \frac{m\lambda}{w}$ with $m = 3$ and $\lambda = 640\times10^{-9}\,m$. Then:

$$w = \frac{m\lambda}{\sin\theta} = \frac{3\,(640\times10^{-9}\,m)}{(4.15\times10^{-3})} = 4.63\times10^{-4}\,m = \boxed{0.463\ mm}$$

3. A photon has energy 6.60 eV.

a) What is the energy of the photon in joules?

$$E = (6.60\,eV)\left(\frac{1.602\times10^{-19}\,J}{1\,eV}\right) = \boxed{1.06\times10^{-18}\,J}$$

b) What is the wavelength of the the photon?

$E = hf = hc/\lambda$, so

$$\lambda = hc/E = \frac{(6.626\times10^{-34}\,J\cdot s)(2.998\times10^{8}\,\tfrac{m}{s})}{(1.06\times10^{-18}\,J)} = 1.88\times10^{-7}\,m$$

$$= \boxed{188\ nm}$$

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

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

$\sin\theta_{\text{br}} = m\frac{\lambda}{d}$ $\quad \sin\theta_{\text{dark}} = \left(m + \frac{1}{2}\right)\frac{\lambda}{d}$ $\quad \sin\theta_{\text{dark}} = m\frac{\lambda}{w}$ $\quad 1\text{ eV} = 1.602\times10^{-19}\text{ J}$

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

Small angle approx:

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