## Physics 111 Homework Solutions Collected on Tuesday

 2/24Friday, February 20, 2015
Questions

- none


## Multiple-Choice

- none


## Problems

21.10 With $f=20 \mathrm{~cm}=0.2 \mathrm{~m}$, we can solve the lens equation for $d_{i}$ to find that in general $d_{i}=\frac{1}{5-\frac{1}{d_{o}}}$ so that we can fill in the following table with different values of $d_{o}$ :

| $d_{o}(m)$ | $d_{i}(m)$ |
| :---: | :---: |
| $\infty$ | 0.20 |
| 4 | 0.21 |
| 2 | 0.22 |
| 1 | 0.25 |
| 0.8 | 0.27 |
| 0.6 | 0.30 |
| 0.4 | 0.40 |
| 0.2 | $\infty$ |

21.11 A lens relay system
a. The magnification is $M=1$, so $d_{o}=d_{\mathrm{i}}$ from magnification equation. Thus using the thin lens equation we find that the focal length is $\frac{1}{f}=\frac{2}{d_{0}} \rightarrow f=\frac{d_{0}}{2}$. To calculate $d_{o}$ we use the fact that $d_{o}+d_{i}=L=1 m$ and thus $\mathrm{d}_{\mathrm{o}}=1 / 2 \mathrm{~m}$. Therefore $f$ $=1 / 4 \mathrm{~m}$.
b. The relay system is shown below where all distances are in meters.


Here the magnification of the lens on the left is $M_{L}=-\frac{d_{o}}{d_{i}}=-\frac{1 / 4}{1 / 4}=-1$ while the magnification of the lens on the right is $M_{R}=-\frac{d_{o}}{d_{i}}=-\frac{1 / 4}{1 / 4}=-1$. Thus the total magnification is $M_{T}=M_{L} M_{R}=-1 \times-1=1$ as is required. The focal length of each lens is $\frac{1}{f}=\frac{1}{d_{o}}+\frac{1}{d_{i}}=\frac{1}{1 / 4}+\frac{1}{1 / 4} \rightarrow f=\frac{1}{8} m$.
21.14 Tom Cruise being in addition to a skilled actor is also an accomplished physicist.

To prove whether or not the reporter was trespassing he proceeds as follows. Since he knows about optics, Tom uses the thin lens and the magnification equations given by $\frac{1}{f}=\frac{1}{d_{o}}+\frac{1}{d_{i}}$ and $M=\frac{d_{i}}{d_{0}}=\frac{h_{i}}{h_{o}}$ respectively. He needs to calculate $d_{o}$. Taking the magnification equation he solve it for $d_{i}$ as $d_{i}=M d_{o}=\left(\frac{h_{i}}{h_{o}}\right) d_{o}$. Using this result and the thin lens equation he has $\frac{1}{f}=\frac{1}{d_{o}}+\frac{1}{d_{i}}=\frac{1}{d_{o}}+\frac{h_{o}}{h_{i} d_{o}}=\frac{1}{d_{o}}\left(1+\frac{h_{o}}{h_{i}}\right)$ $d_{o}=\left(\frac{h_{i}+h_{o}}{h_{i}}\right) f=\left(\frac{2.89 \mathrm{~mm}+620 \mathrm{~mm}}{2.89 \mathrm{~mm}}\right) \times 210 \mathrm{~mm}=45 \times 10^{3} \mathrm{~mm}=45 \mathrm{~m}$
Since this is about 135 feet, the reporter could be trespassing, as it depends on where Tom and the baby were standing on his property. More than likely the reporter was trespassing.

## Monday, February 23, 2015

Questions

- none


## Multiple-Choice

- none


## Problems

- same as Friday 2/20/15

