Name: _____ DISC: _____ Score: _____ / 20

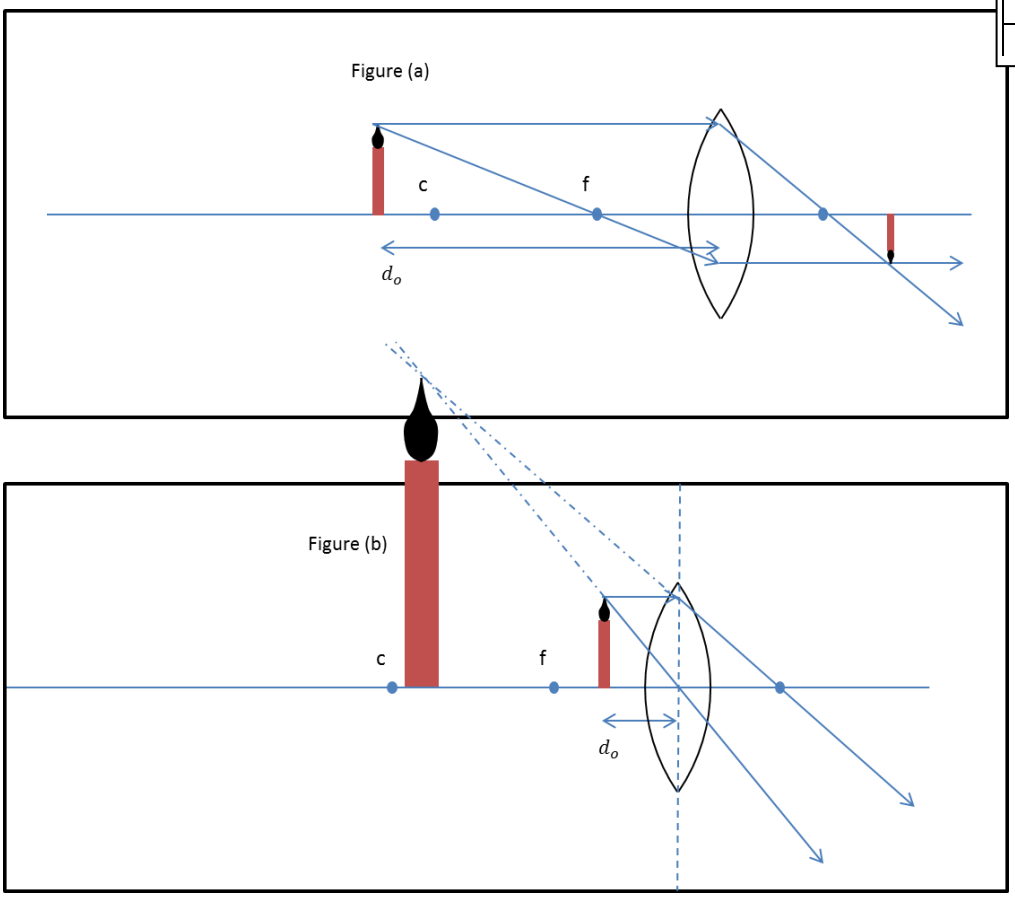
Instructions:

- Do your own work.
- Answer the questions below in the space provided.
- ***You must show all of your work to received credit for these problems***
- Please place a box around your answers.
- Remember to give the correct units with all numerical answers

| Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|
| | | | |
| 10 | 10 | 5 | 5 |

| | |
|---|---|
| SPEED OF LIGHT | $c = 3 \times 10^8 m/s$ |
| LENS EQN | $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$ |
| MAGNIFICATION | $m = -d_i/d_o$ |
| FOCAL LENGTH | $10\ cm$ |

1. Consider the convex lenses and sets of candle below:




Ray-Traces (2 pts.):

a) Draw the ray-trace diagrams for *at least two (2)* principle rays to locate the image in each diagram.

b) Fill in the following table:

Table (8 pts.):

| FIGURE | IMAGE TYPE | IMAGE LOCATION | ORIENTATION | MAGNIFICATION |
|---|---|---|---|---|
| a: $d_o = 25\ cm$ | REAL/VIRTUAL/NO IMAGE | $\mathbf{16.67\ cm}$ | UPRIGHT/INVERTED/NO IMAGE | $\mathbf{= -0.667}$ |
| b: $d_o = 5\ cm$ | REAL/VIRTUAL/NO IMAGE | $\mathbf{\rightarrow -10\ cm}$ | UPRIGHT/INVERTED/NO IMAGE | $\mathbf{2}$ |

$$\boldsymbol{(a)}: \frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \rightarrow \frac{1}{10\ cm} - \frac{1}{25\ cm} = \frac{1}{d_i}$$

$$\frac{25\ cm - 10\ cm}{250\ cm^2} = \frac{15}{250}\frac{1}{cm} = \frac{3}{50}\frac{1}{cm} \rightarrow \frac{50}{3} cm = 16.67\ cm = d_i$$

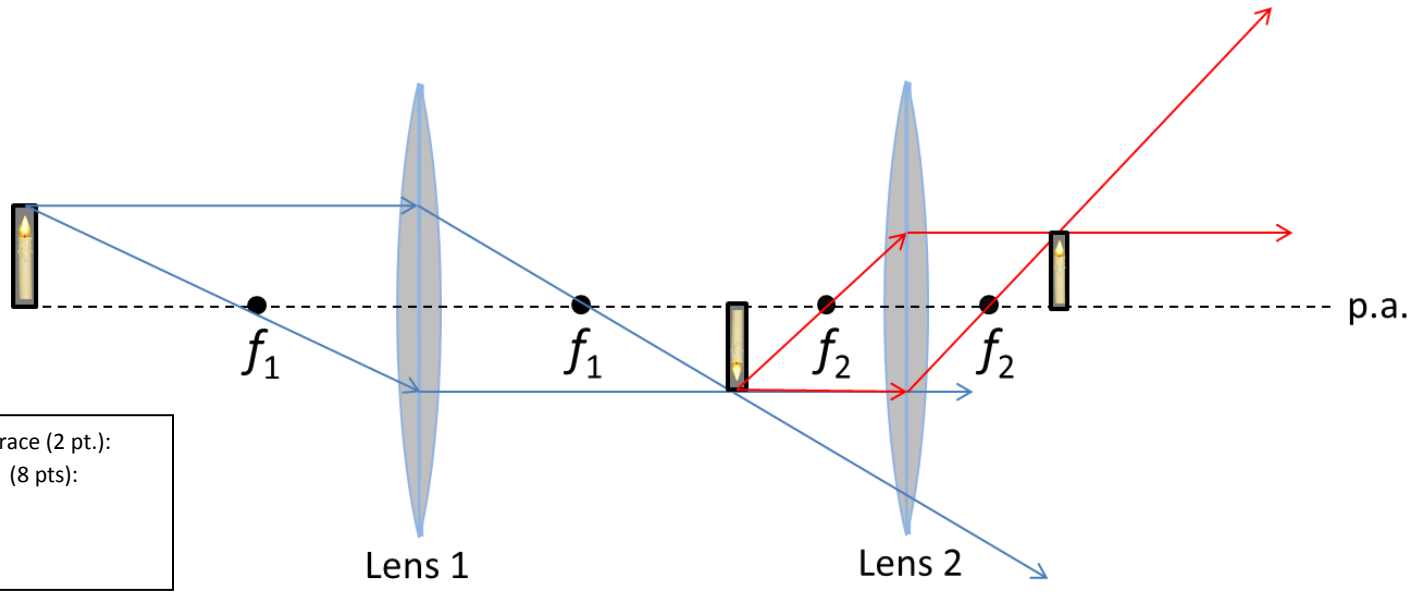
$$m = -\frac{d_i}{d_o} = -\frac{16.67}{25} = -0.667$$

$$\boldsymbol{(b)}: \frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \rightarrow \frac{1}{10\ cm} - \frac{1}{5\ cm} = \frac{1}{d_i}$$

$$\frac{5\ cm - 10\ cm}{50\ cm^2} = \frac{-5}{50}\frac{1}{cm} = \frac{-1}{10}\frac{1}{cm} \rightarrow -10\ cm = d_i$$

$$m = -\frac{d_i}{d_o} = -\frac{-10}{5} = 2$$

2. Consider the two-lens system below:




Ray Trace (2 pt.):
Table (8 pts):

a) Use the ray-tracing technique to find the location of the image.

b) Use the thin-lens equations to fill in the values requested in the table. The candle is at $d_o = 25\ cm$ to the left of Lens 1. The lenses are separated by $d_{spe} = 30\ cm$.

| LENS | FOCAL LENGTHS | IMAGE TYPE | IMAGE LOCATION | ORIENTATION | MAGNIFICATION |
|---|---|---|---|---|---|
| 1 | $f_1 = 10\ cm$ | REAL/VIRTUAL/NO IMAGE | **16.67 cm, from lens 1** | UPRIGHT/INVERTED/NO IMAGE | **−0.667** |
| 2 | $f_2 = 5\ cm$ | REAL/VIRTUAL/NO IMAGE | **8.00 cm, from lens 2** | **UPRIGHT/INVERTED/NO IMAGE | **0.400** |

**Lens 1:** $\frac{1}{d_{i_1}} = \frac{1}{f_1} - \frac{1}{d_o} = \frac{1}{10} - \frac{1}{25} = 0.1 - 0.04 = 0.06$; **therefore,** $d_{i_1} = 16.67\ cm$, **from lens 1**

$$m = -\frac{d_{i_1}}{d_o} = -\frac{16.67}{25} = -0.667$$

**Lens 2:** $\frac{1}{d_{i_2}} = \frac{1}{f_2} - \frac{1}{(d_{sep} - d_{i_1})} = \frac{1}{5} - \frac{1}{13.33} = 0.2 - 0.075 = 0.125$; **therefore,** $d_{i_2} = 8.00\ cm$, **from lens 2**

$$m = -\frac{d_{i_2}}{d_o} = -\frac{8.00}{13.33} = -0.600$$

**Overall Magnification:** $m = m_1 m_2 = (-0.667) \times (-0.600) = 0.400$

****Inverted with respect to the object for lens 2—Upright with respect to the original object.**

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