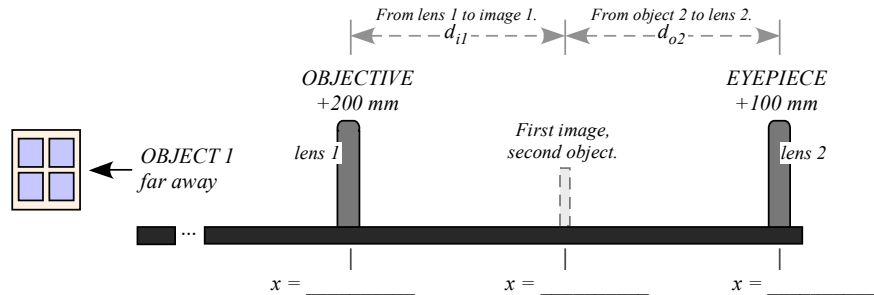


Lab Report: The Telescope and the Microscope

Name: _____

DATA TABLE PROCEDURE A: The Astronomical Telescope: Looking at a Far Away Object**Summary of Positions:****Visual Description of the First Image:**

Orientation: _____

Magnification: _____

Type: _____

Summary of Distances:FIRST IMAGE: $d_{o1} \rightarrow \infty$ $d_{i1} = \text{_____ cm}$

FINAL IMAGE: $d_{o2} = \text{_____ cm}$

$d_{i2} = \text{_____ cm}$ (calculated) $\left. \vphantom{\begin{matrix} d_{o2} \\ d_{i2} \end{matrix}} \right\} \rightarrow m_2 = \frac{-d_{o2}}{d_{i2}} =$

Visual Estimate of the Total Magnification:

Apparent height of image $h_i = \text{_____}$

Apparent height of object $h_o = \text{_____}$

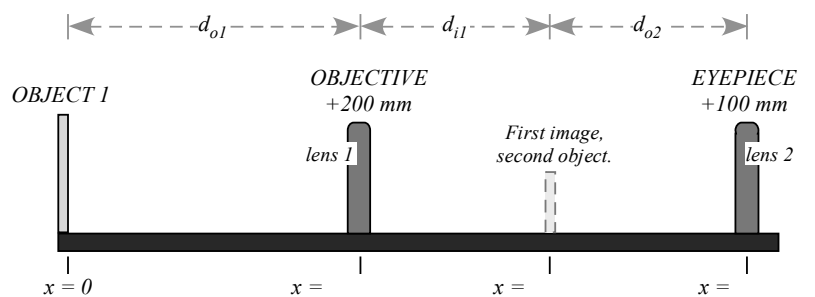
$M_{\text{visual}} = \frac{-h_i}{h_o} =$

Theoretical Total Magnification:

Objective focal length $f_1 = \text{_____}$

Eyepiece focal length $f_2 = \text{_____}$

$M = \frac{-f_1}{f_2} =$

DATA TABLE PROCEDURE B: The Astronomical Telescope: Looking at a Nearby Object**Summary of Positions:****Visual Description of the First Image:**

Orientation: _____

Magnification: _____

Type: _____

Summary of Distances:

$$\text{FIRST IMAGE: } \left. \begin{array}{l} d_{o1} = \text{_____ cm} \\ d_{i1} = \text{_____ cm} \end{array} \right\} \rightarrow m_1 = \frac{-d_{i1}}{d_{o1}} =$$

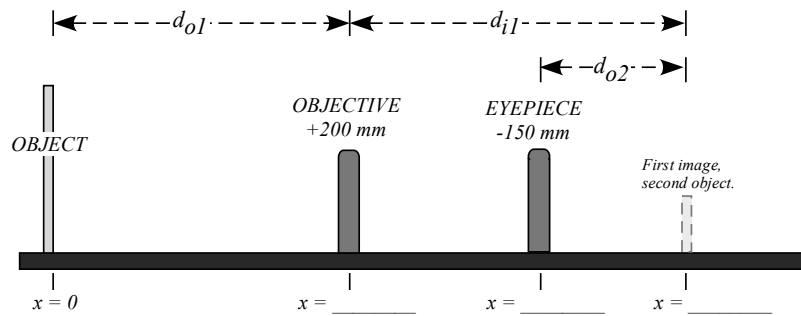
$$\text{FINAL IMAGE: } \left. \begin{array}{l} d_{o2} = \text{_____ cm} \\ d_{i2} = \text{_____ cm} \\ \text{(calculated)} \end{array} \right\} \rightarrow m_2 = \frac{-d_{i2}}{d_{o2}} =$$

Visual Estimate of the Total Magnification:

$$\left. \begin{array}{l} \text{There are } n_o = \text{_____ squares of the object,} \\ \text{inside } n_i = \text{_____ squares of the image.} \end{array} \right\} M_{\text{visual}} = \frac{-n_o}{n_i} =$$

Theoretical Total Magnification:

$$M = m_1 m_2 =$$

DATA TABLE PROCEDURE C: The Galilean Telescope: Using a Negative Eyepiece**Summary of Positions:****Visual Description of the First Image:**

Orientation: _____

Magnification: _____

Type: _____

Summary of Distances:

FIRST IMAGE: $\left. \begin{array}{l} d_{o1} = \text{_____ cm} \\ d_{i1} = \text{_____ cm} \end{array} \right\} \rightarrow m_1 = \frac{-d_{i1}}{d_{o1}} =$

FINAL IMAGE: $\left. \begin{array}{l} d_{o2} = \text{_____ cm} \\ d_{i2} = \text{_____ cm} \\ \text{(calculated)} \end{array} \right\} \rightarrow m_2 = \frac{-d_{o2}}{d_{i2}} =$

Visual Estimate of the Total Magnification:

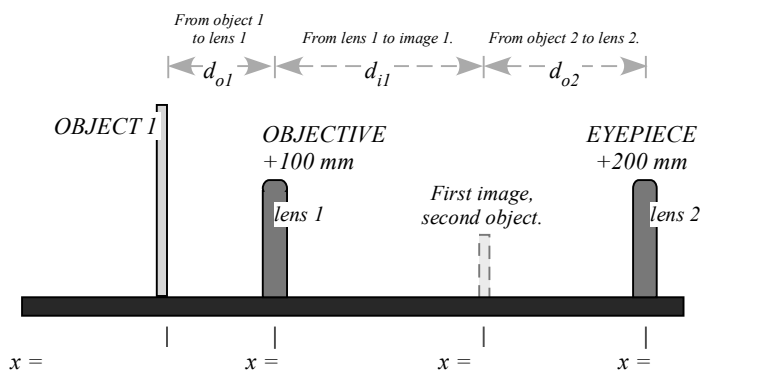
There are $n_o = \text{_____}$ squares of the object, inside $n_i = \text{_____}$ squares of the image. $\left. \right\} M_{\text{visual}} = \frac{n_o}{n_i} =$

Theoretical Total Magnification:

$$M = m_1 m_2 =$$

DATA TABLE PROCEDURE D: The Compound Microscope: Looking at a Nearby but Very Small Object

Summary of Positions:



Orientation: _____

Visual Description of the First Image:

Magnification: _____

Type: _____

Summary of Distances:

FIRST IMAGE: $\left. \begin{array}{l} d_{o1} = \underline{\hspace{2cm}} \text{ cm} \\ d_{i1} = \underline{\hspace{2cm}} \text{ cm} \end{array} \right\} \rightarrow m_1 = \frac{-d_{i1}}{d_{o1}} =$

FINAL IMAGE: $\left. \begin{array}{l} d_{o2} = \underline{\hspace{2cm}} \text{ cm} \\ d_{i2} = \underline{\hspace{2cm}} \text{ cm} \\ \text{(calculated)} \end{array} \right\} \rightarrow m_2 = \frac{-d_{o2}}{d_{i2}} =$

Total Magnification:

$$M = m_1 m_2 =$$

What is the message?

QUESTIONS for PROCEDURES A, B and C: Telescopes

1. It should have been immediately obvious that when you look through the astronomical telescope (procedures A and B) the image is upside down. Discuss: Is this a big problem when making astronomical observations?
2. In contrast: What is the orientation of the final image in the Galilean telescope?
3. Is the final image from a telescope real or virtual? How can you tell?
4. How good were your visual estimates of the total magnification of the telescopes, as compared to the theoretically expected values? Discuss what makes the visual estimates hard to measure in each case.

5. According to Eq. 3, the total magnification of a two-lens system is $M = m_1 m_2$. Go to Procedure A: use the theoretical magnification and the calculated value for m_2 , to calculate what must have been the magnification of the first image, m_1 . Does the value of matches your visual observations? Discuss.

6. Use your calculation of m_1 (question 4) and Eq. 2 to determine the distance from the objective to the object, d_{o1} (the one we assumed was infinite). Discuss: does the calculated distance seem realistic, given the actual object you were looking at? Why yes or why not? Was it reasonable, then, to assume that $d_{o1} \rightarrow \infty$?

7. In general, which type of telescope would require a longer tube-length, an astronomical telescope or a Galilean telescope? Why?

QUESTIONS for PROCEDURE D: The Compound Microscope

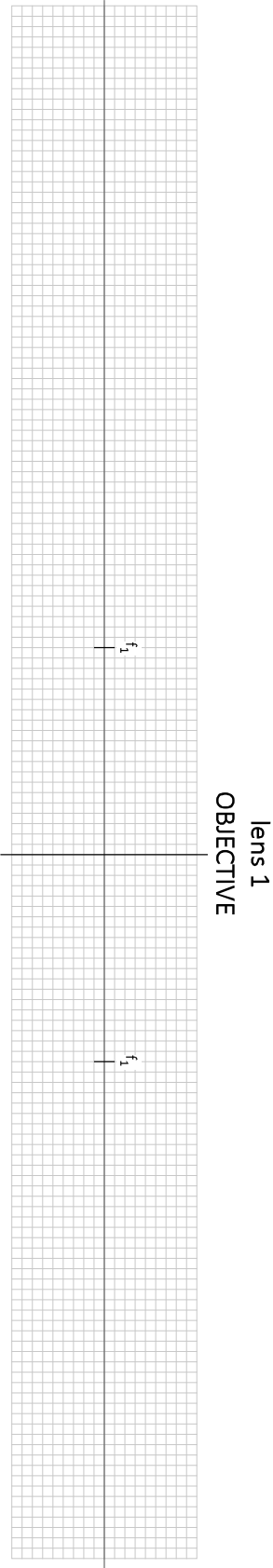
1. Is the final image of the microscope upright or upside down?

2. Is the final image of the microscope real or virtual? How can you tell?

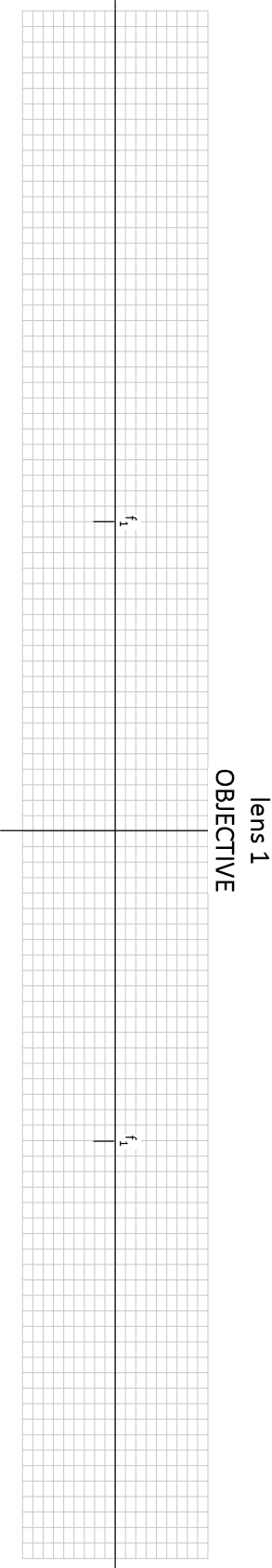
RAY DIAGRAMS

Use the grids provided in the next pages to trace principal ray diagrams for Procedures B, C and D.

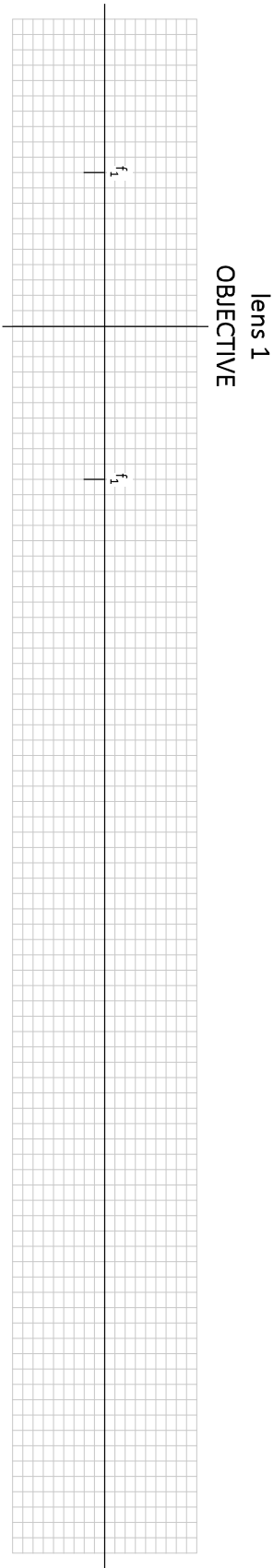
PROCEDURE B: The Astronomical Telescope: Looking at a Nearby Object



PROCEDURE C: The Galilean Telescope: Using a Negative Eyepiece



PROCEDURE D: The Compound Microscope



GRID PATTERN
Copy and attach to the Viewing Screen

