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Lab 09 – Thin Lenses

Complete this lab worksheet and turn it in for credit. Show all your work including the calculations you performed (attach additional sheets if necessary).

9.4.1

1. Determine the focal length of your lens.

f = 25 cm

9.4.2

1. Measure the height of the object. arrow $3\frac{3}{10}$cm = 3.3cm

Image height
3cm

h_0 = 3.3 cm

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Lens	configuration	d_0 (cm)	d_i (cm)	h_i (cm)	Real/Virtual	Upright/Inverted	Larger/Smaller
Converging	d0>2f	60	19.3	1.5	virtual	Inverted	Smaller
	d0=2f	50	20.5	1.7	Virtual	inverted	Smaller
	f<d0<2f	33	26	2.6	real	inverted	smaller
	d0=f	25	No	Image will be made			

	$d_0<f$	19	59.5	11	Virtual	Invertel	Larger
~~diverging~~	~~$f<d_0<2f$~~						
	~~$d_0=f$~~						
	~~$d_0<f$~~						

Magnification

$$M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

1 Fill in the table. For virtual images leave d_i and h_i blank.

Page Break

Converging lens

configuration	f (cm) use your measurements of d_i and d_o	m Use your measurements of h_i and h_o	m use your measurements of d_i and d_o
$d_0>2f$	virtual, 60cm	virtual, 3.3cm	virtual, 60cm
$d_0=2f$	virtual, 50cm	virtual, 3.3cm	virtual, 50cm
$f<d_0<2f$	26cm, 33cm 14.54 cm	2.6cm, 3.3cm .78	26cm, 33cm -.78

Lens	configuration	d_o (cm)	d_i (cm)	h_i (cm)	Real/Virtual	Upright/Inverted	Larger/Smaller
Converging	$d_0>2f$	60	19.3	1.5	virtual	Invertel	Smaller
	$d_0=2f$	50	20.5	1.7	Virtual	inverted	Smaller
	$f<d_0<2f$	33	26	2.6	real	inverted	smaller
	$d_0=f$	25	No		Image	will	be Made
	$d_0<f$	19	59.5	11	Virtual	Invertel	Larger

1. Compute the percent different between each value of f above, and the value you found in 9.4.1. Compare these values. Was one better than any of the others? Were any particularly worse?

$$\text{diff} = \left| \frac{x_1 - x_2}{\left(\frac{x_1 + x_2}{2}\right)} \right| \cdot 100\%$$

$$\left| \frac{25 - 14.54}{\left(\frac{25 + 14.54}{2}\right)} \right| = .524 \times 100\%$$

$$= 52.4\%$$

1. Compute the average value of m for each column in the table above. Then compare the two values of m. Do they agree? Explain.

We only have 2 magnifications with both being the same but opposite sign. Therefore not enough data to find an accurate average. Due to virtual = blank.

9.4.3 Ray Tracing

On the graph included graph paper draw ray diagrams for the cases below. Make each diagram quantitatively correct. The height should be 1:1 (1 box = 1 cm), but you will need to decide on the proper scale for the horizontal direction.

1 The case

$$d_0>2f$$

for the converging lens. Use only the values for f, ho and do. Then measure h_i and d_i from the diagram. How does it compare to what you measured and computed above?

Page Break

Converging lens

configuration	f (cm) use your measurements of d_i and d_o	m Use your measurements of h_i and h_o	m use your measurements of d_i and d_o
$d_0>2f$	virtual, 60cm	virtual, 3.3cm	virtual, 60cm
$d_0=2f$	virtual, 50cm	virtual, 3.3cm	virtual, 50cm
$f<d_0<2f$	26cm, 33cm	2.6cm, 3.3cm	26cm, 33cm

2 The case

$$d_0<f$$

for the converging lens. Use only the values for f, h_o and d_o. Then measure h_i and d_i from the diagram. Compare do what you get using equations 9.1 and 9.2.

3 The case

$d_0<f$

for the diverging lens. Use only the values for *f, h_o* and *d_o*. Then measure *h_i* and *d_i* from the diagram. Compare do what you get using equations 9.1 and 9.2.

$$\frac{1}{f}=\frac{1}{d_0}+\frac{1}{d_i} \Rightarrow \frac{1}{20}=\frac{1}{15}+\frac{1}{d_i} \Rightarrow d_i=\left(\frac{1}{20}-\frac{1}{15}\right)^{-1}=-60\,cm$$

$$\frac{h_i}{h_0}=-\frac{d_i}{d_0} \Rightarrow h_i=-\frac{h_0 d_i}{d_0} \Rightarrow h_i=-\frac{(3)(-60)}{15}=12\,cm$$

$d_0=15$

$d_i=-60$

$f=20$

$h_0=3$

$h_i=12$

1 The case

$d_0 > 2f$

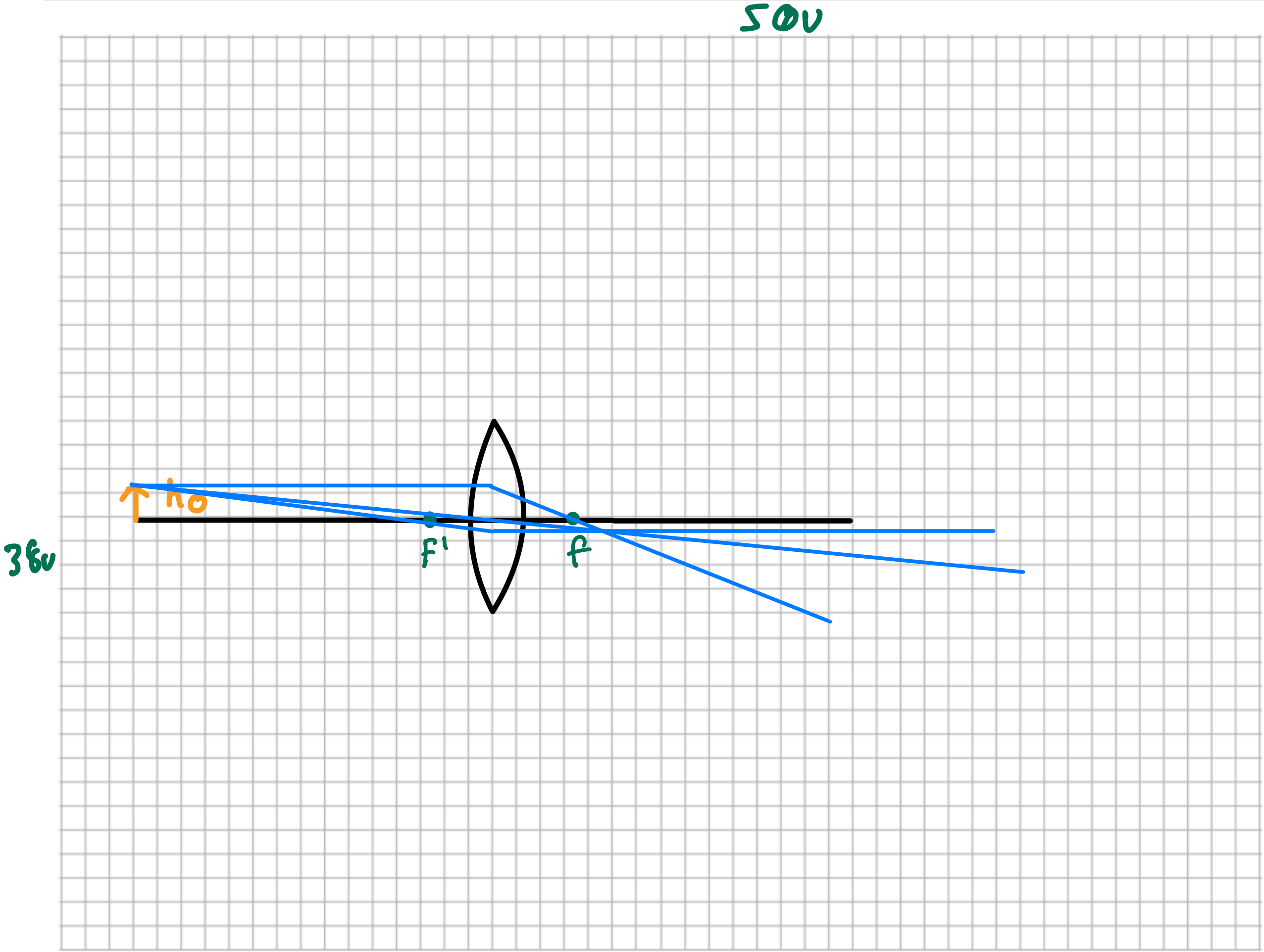
for the converging lens. Use only the values for f, ho and do. Then measure h_i and d_i from the diagram. How does it compare to what you measured and computed above?

Page Break

Converging lens

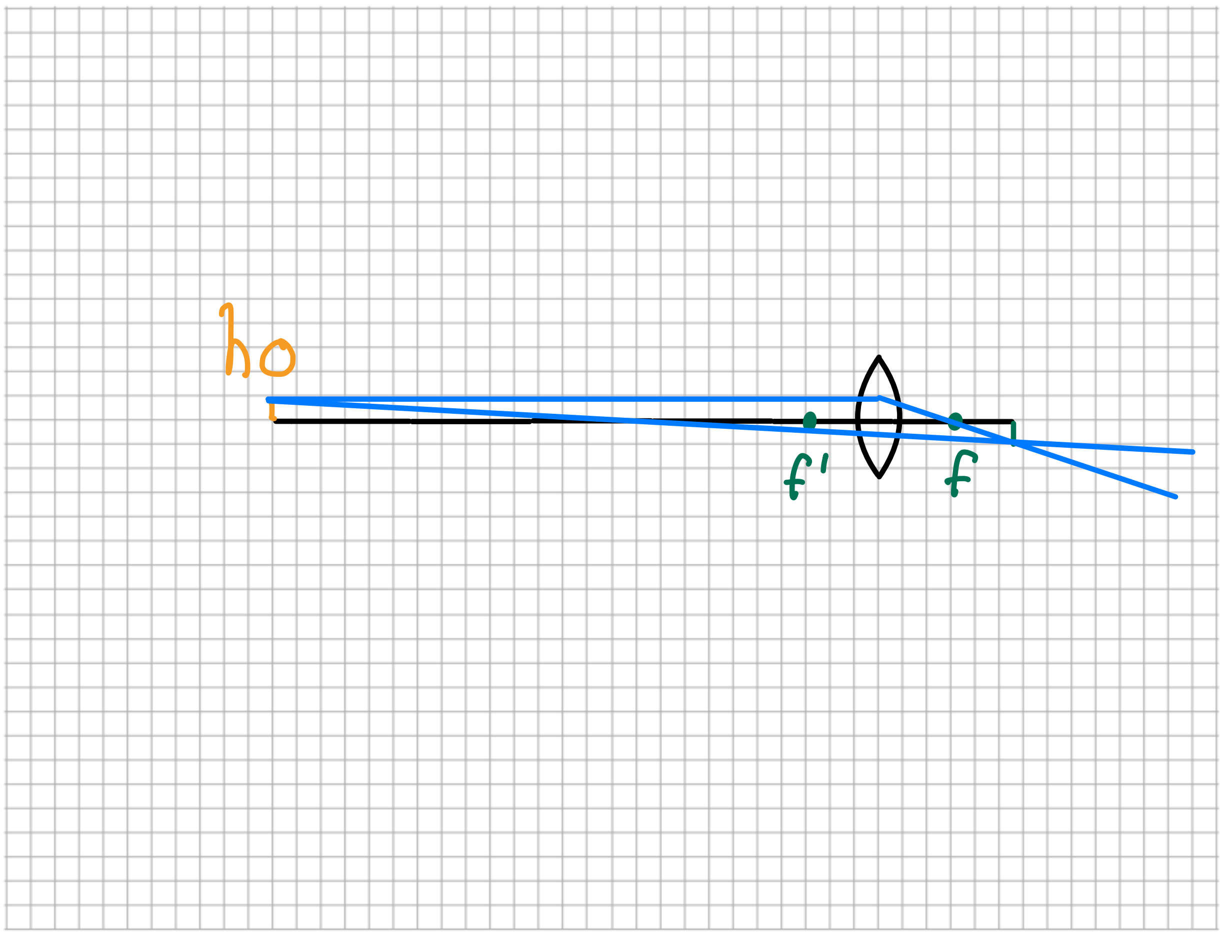
configuration	f (cm) use your measurements of d_i and d_o	m Use your measurements of h_i and h_o	m use your measurements of d_i and d_o
$d_0 > 2f$	virtual, 60cm	virtual, 3.3cm	virtual, 60cm

Lens: Converging Case: one Scale: 1:3 boxes/cm


50u
38u
h_o
F'
F

Lens	configuration	d_0 (cm)	d_i (cm)	h_i (cm)	Real/Virtual	Upright/Inverted	Larger/Smaller
converging	$f<d_0<2f$	33	26	2.6	real	inverted	smaller

Lens: Converging Case: TWO Scale: 1:5 boxes/cm


ho
f'
f

$$\frac{1}{f}=\frac{1}{d_o}+\frac{1}{d_i} \Rightarrow \frac{1}{20}=\frac{1}{15}+\frac{1}{d_i} \Rightarrow d_i=\left(\frac{1}{20}-\frac{1}{15}\right)^{-1}=-60\text{cm}$$

$$\frac{h_i}{h_o}=-\frac{d_i}{d_o} \Rightarrow h_i=-\frac{h_o d_i}{d_o} \Rightarrow h_i=-\frac{(3)(-60)}{15}=12\text{cm}$$

$d_o=15$

$d_i=-60$

$f=20$

$h_o=3$

$h_i=12$

Lens: Diverging Case: 3 Scale: 1 box : 3cm boxes/cm

$d_o = 15$

$d_i = -60$

$f = 20$

$h_o = 3$

$h_i = 12$