Magnification   Magnif < 1, = 1, > 1   extra

Name: ______________________ Date: ______________

Lens Equations

all same unit (m, cm)

Use the following equations to solve both Part A and Part B below:

Thin Lens Equation: $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$

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

d_o = distance to object (m)
d_i = distance to image (m)
f = focal length (m)

Part A: Fill in the blanks below with a variable from the equations above.

h_o = height obj.
h_i = " image
M = magnification

1. __+ d_o__ is always positive no matter what lens is used.
2. __+ d_i__ is positive if the image is real. (behind)
3. __− d_i__ is negative if the image is virtual. (in front)
4. The focal length (f) is __+__ for a converging lens.
5. The focal length (f) is __−__ for a diverging lens.
6. __h_o__ and __h_i__ heights are positive when measured upward from the principal axis and negative when measured downward. ↑ + ↓ −
7. __M__ is positive for an upright image and negative for an inverted image. ↑+ ↓−

Part B: Use the thin lens equation and magnification equation to solve the problems below. Show your work.

1. A statue with a height of 15 cm is placed in front of a converging lens. An inverted image of height 38 cm is noticed on the other side of the lens. (+f)

   (a) Use the magnification equation to calculate the magnification of the lens.

   G: h_o = 15 cm h_i = −38 cm   R: M = ?
   A: M = h_i / h_o
   S: M = −38 / 15 = −2.5   Magnification is −2.5x

   (b) What type of image is it?

   (larger + upside down)

2. A converging lens has a focal length of 14 cm. A candle is located 32 cm from the lens. Where will the image be located?

   G: f = 14 cm d_o = 32 cm   R: d_i = ?
   A: $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$ S: $\frac{1}{32} + \frac{1}{d_i} = \frac{1}{14}$

   $\frac{1}{d_i} = 0.071 - 0.031$

   $\frac{1}{d_i} = 0.04$ (d_i)

   d_i = 25 cm

   * on another sheet

Name: ______________________ Date: ______________

Lens Equations *(continued)*

3. A coffee cup of height 18 cm is placed in front of a converging lens. An inverted, real image of height 5.3 cm is noticed on the other side of the lens. What is the magnification of the lens?

G: $h_o = 18$ cm $h_i = 5.3$ cm R: M A: $M = h_i / h_o$

S: $M = \frac{-5.3 \text{ cm}}{18 \text{ cm}} = -0.29\times$

P: Magnification $= -0.29\times$

4. A bottle cap of height 3.4 cm is placed in front of a diverging lens. On the same side of the lens as the cap, a virtual image of height 1.6 cm is noticed.

$h_o = 3.4$ cm, $h_i = 1.6$ cm; $f = -$ve

(a) What is the magnification of the lens?

$M = h_i / h_o = \frac{1.6 \text{ cm}}{3.4 \text{ cm}} = 0.47\times$ Mag $= 0.47\times$

(b) What is the attitude of the image?

It is upright b/c mag is +ve

5. A diverging lens has a focal length of 25 cm. A virtual image of a jar is located 10 cm in front of the lens. Where is the jar located?

$f = -25$ cm, $d_i = -10$ cm, $d_o = ?$

$\frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{f}$ ∴ $\frac{-1}{10} + \left(-\frac{1}{25}\right) = \frac{1}{f}$

$-0.10 - 0.04 = 1/f$ $f = -17$ cm

6. A bird's nest is 38 cm from a converging lens. This lens has a focal length of 18 cm. Use the thin lens equation to calculate where the image of the nest will be located.

$d_o = 38$ cm, $f = 18$ cm, $d_i = ?$

$\frac{1}{d_i} + \frac{1}{d_o} = 1/f$ ∴ $\frac{1}{38} + \frac{1}{d_i} = \frac{1}{18}$

$1/d_i = 0.056 - 0.026$ | $1/d_i = 0.03$ $d_i = 33$ cm

7. A cup is located 20 cm from a diverging lens. An upright, virtual image of the cup is observed −8 cm from the lens. Calculate the focal length of this lens.

$d_o = 20$ cm, $d_i = -8$ cm, f

$1/f = \frac{1}{d_i} + \frac{1}{d_o} = \frac{-1}{8} + \frac{1}{20}$

$1/f = -0.125 + 0.05$ // $1/f = -0.075$ $f = -13$ cm

8. A converging lens has a focal length of 16 cm. A mouse is located 26 cm from the lens. Where will the image of the mouse be located?

$f = 16$ cm, $d_o = 26$ cm, $d_i = ?$

$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$ $\frac{1}{d_i} = \frac{1}{16} - \frac{1}{26}$

$\frac{1}{d_i} = 0.063 - 0.038$