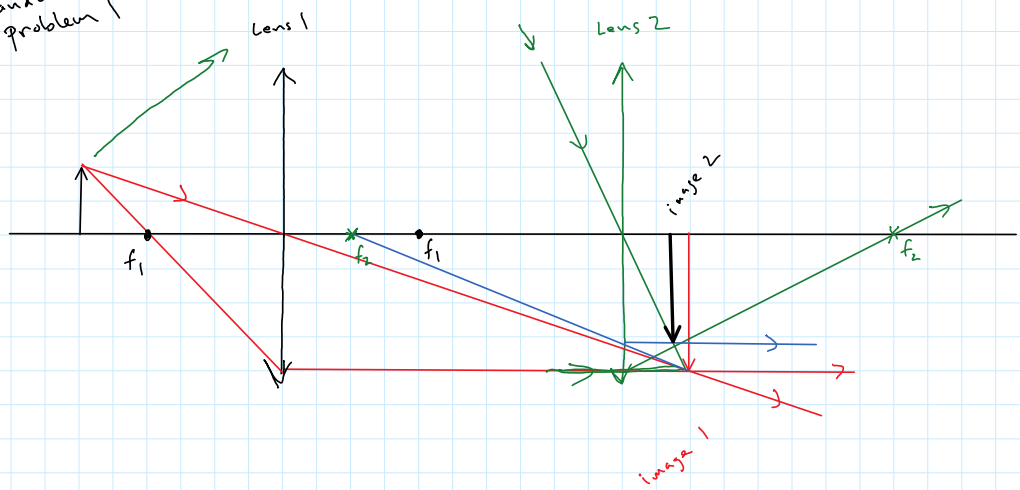
Phy 4C 3/6

Friday, March 3, 2017 1:43 PM

Lens / Lens Combinations

Lens / mirror combinations

Handout problem 1



Lens 1

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$\frac{1}{30} + \frac{1}{q} = \frac{1}{20}$$

$$q = 60 \text{ cm}$$

$$M = -\frac{q}{p} = -\frac{60}{30} = -2$$

$$h' = 4 \text{ cm}$$

Lens 2

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$\frac{1}{-10} + \frac{1}{q} = \frac{1}{40}$$

$$q = 8 \text{ cm}$$

$$M = -\frac{8}{-10} = +0.8$$

$$h'' = (4 \text{ cm})(0.8) = 3.2 \text{ cm}$$

Combined magnification: $M_1 \times M_2$

$$(-2)(0.8)$$

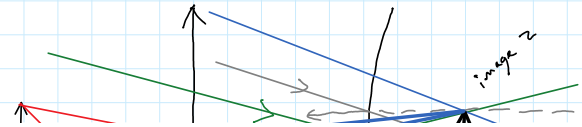
$$-1.6$$

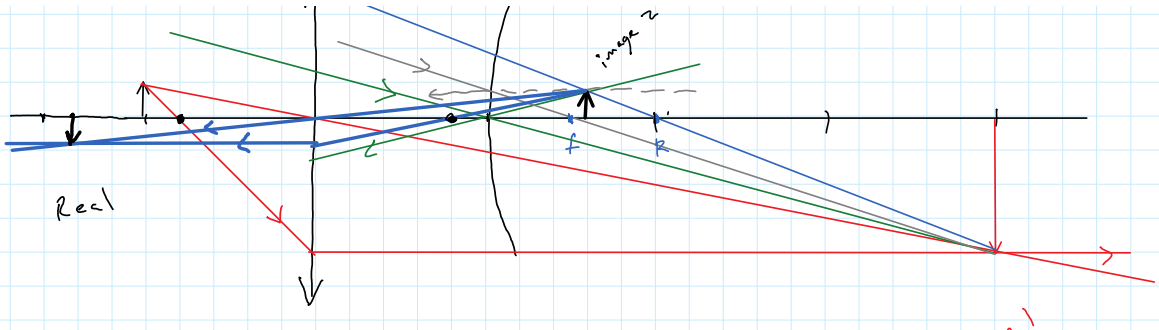
original $h = 2$ cm

final $h'' = 2(1.6) = 3.2$ cm inverted since $M = -1.6$ (↑ inverted)

Real image

Handout Book Prob 36-77





Lens

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$\frac{1}{1} + \frac{1}{q} = \frac{1}{0.8}$$

$$q = 4 \text{ m}$$

$$M = -\frac{4}{1} = -4$$

Mirror

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$\frac{1}{3} + \frac{1}{q} = \frac{1}{-0.5}$$

$$q = -0.6 \text{ m}$$

$$M = -\frac{-0.6}{3} = -0.2$$

Lens (2nd time)

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$\frac{1}{1.6} + \frac{1}{q} = \frac{1}{0.8}$$

$$q = 1.6 \text{ m}$$

p is positive because positive side is the side the light comes from and the object is on that side (it happens to be the Right side of the lens)

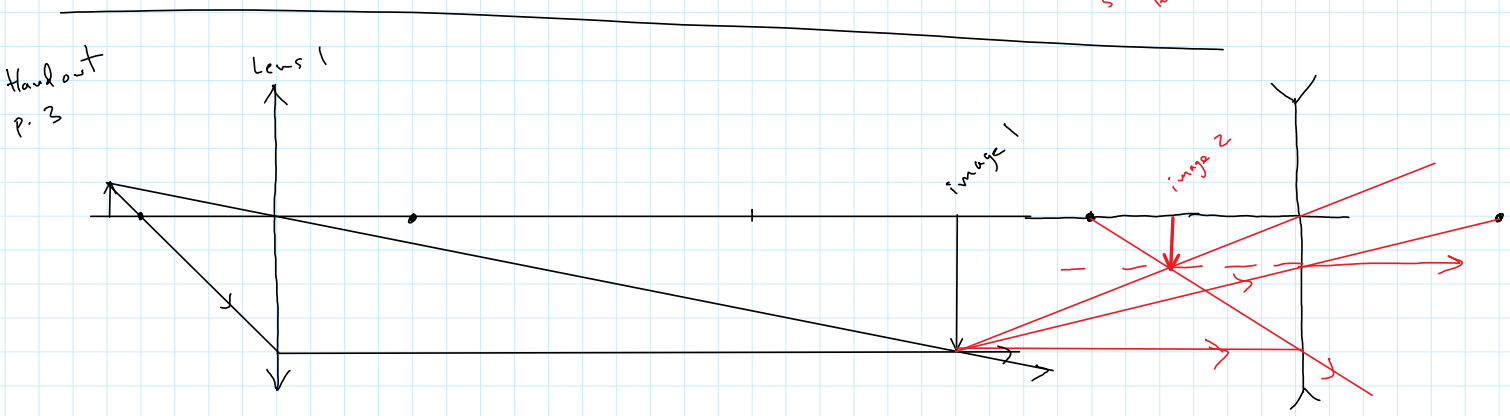
$$M = -\frac{1.6}{1.6} = -1$$

overall mag: $m_1 \times m_2 \times m_3$

$$(-4)(-0.2)(-1)$$

$$-0.8$$

Handout p. 3



Lens 1

$$\frac{1}{50} + \frac{1}{q} = \frac{1}{40}$$

$$q = 200 \text{ cm}$$

$$M = -\frac{200}{50} = -4$$

$$h' = (1.2 \text{ cm})\,4 = 4.8 \text{ cm}$$

Lens 2

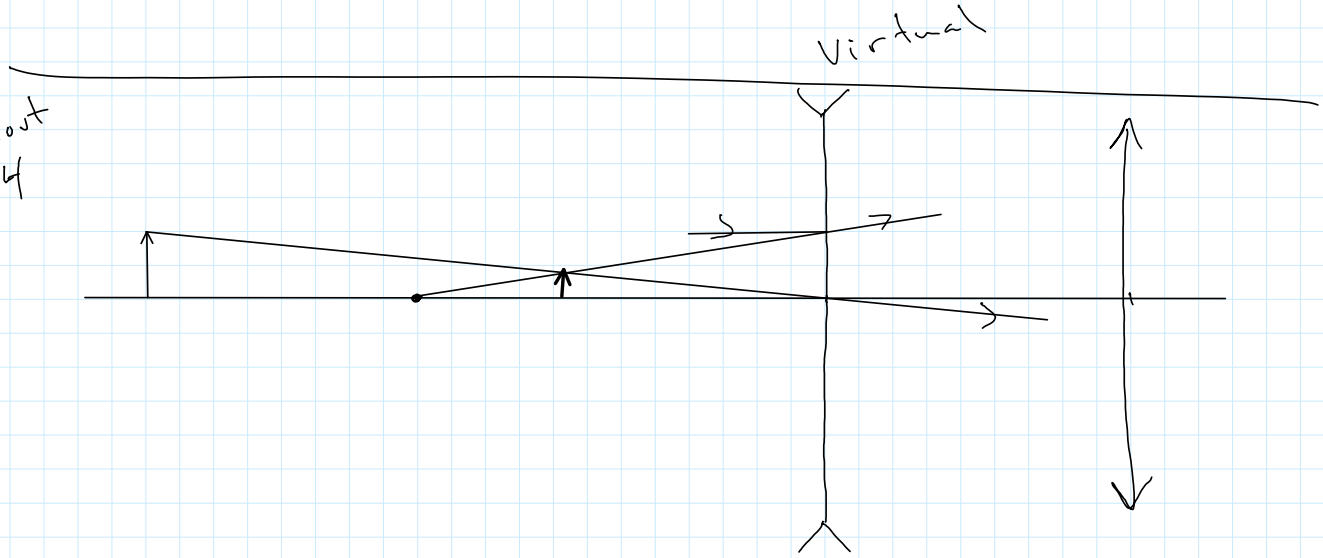
$$\frac{1}{100} + \frac{1}{q} = \frac{1}{-60}$$

$$q = -37.5 \text{ cm}$$

$$M = -\frac{-37.5}{100} = +0.375$$

$$h'' = (4.8 \text{ cm})(0.375) = 1.8 \text{ cm}$$

Handout p. 4



Lens 1

$$\frac{1}{20} + \frac{1}{q} = \frac{1}{-12}$$

$$q = -7.5 \text{ cm}$$

$$M = -\frac{-7.5}{20} = +0.375$$

Lens 2

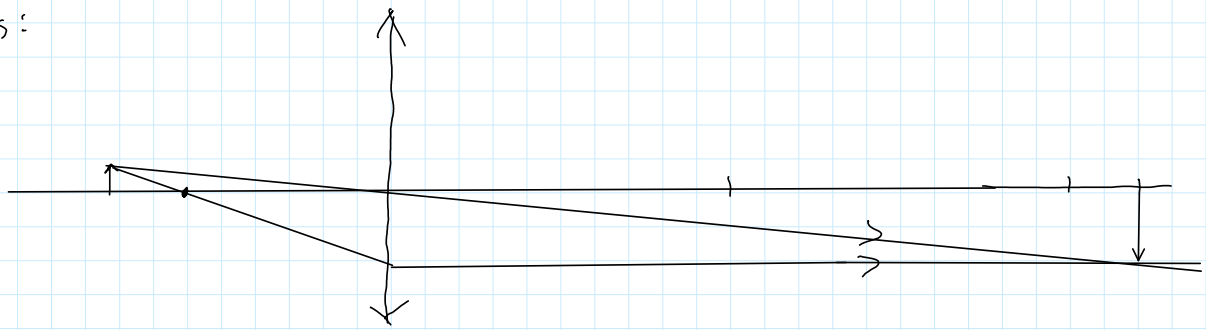
$$\frac{1}{16.5} + \frac{1}{q} = \frac{1}{12}$$

$$q = 44 \text{ cm}$$

$$M = -\frac{44}{16.5} = -2.67$$

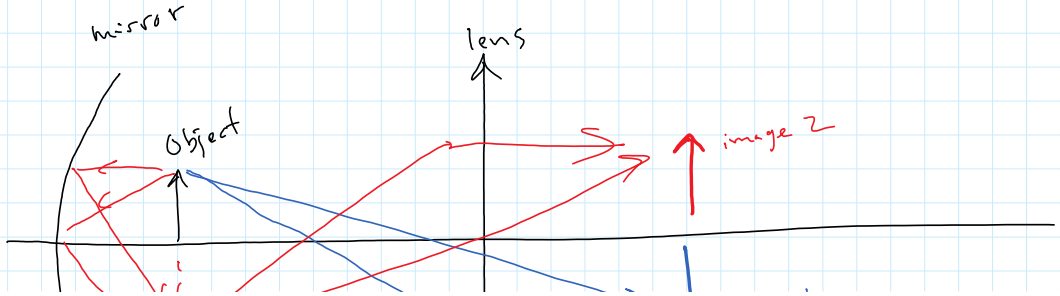
$$M_{total} = (0.375)(-2.67) = -1$$

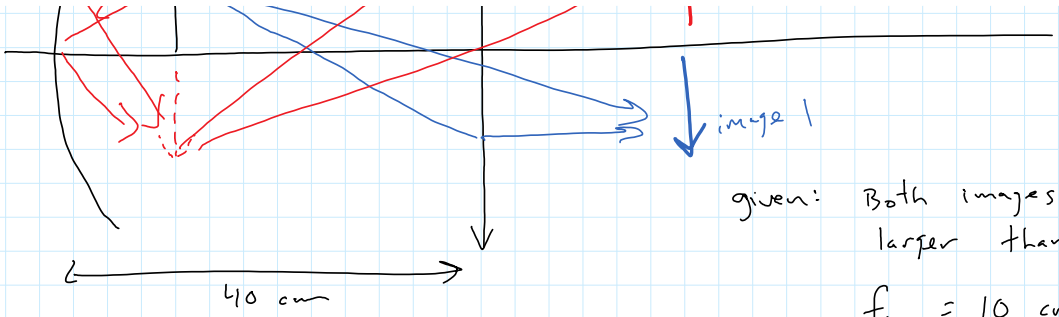
2nd lens:



Real

book Prob 35-89





observer

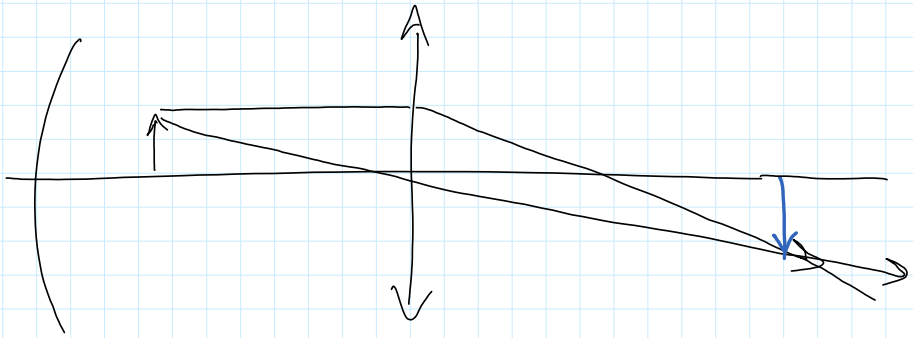
given: Both images are 1.5 x larger than object

$f_{lens} = 10$ cm

both images are at same location

find: f_{mirror}

Image 1 Light from object to lens



$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} \qquad \text{and} \qquad -\frac{q}{p} = -1.5$$

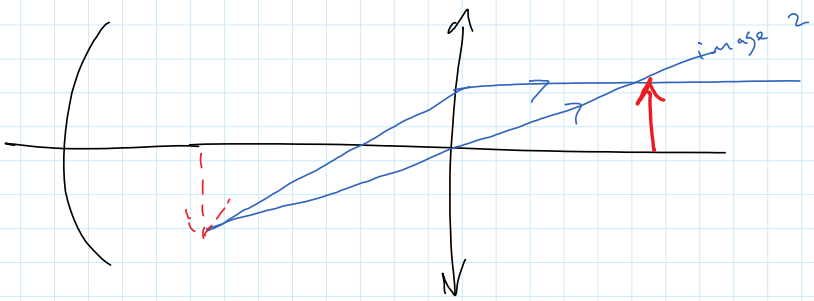
$$q = 1.5p$$

$$\frac{1}{p} + \frac{1}{1.5p} = \frac{1}{10}$$

$p = 16.7$ cm

$q = 1.5p = 25$ cm

What object would make image 2?



$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

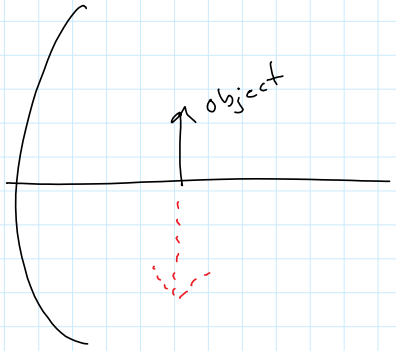
$$-\frac{q}{p} = -1.5$$

$$q = 1.5\,p$$

$$25 = 1.5\,p$$

$$p = 16.7$$

Use mirror:



$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$p = 40 - 16.7 = 23.3$$

$$q = 40 - 16.7 = 23.3$$

$$\frac{1}{23.3} + \frac{1}{23.3} = \frac{1}{f}$$

$$f = \frac{23.3}{2} = 11.6 \text{ cm}$$