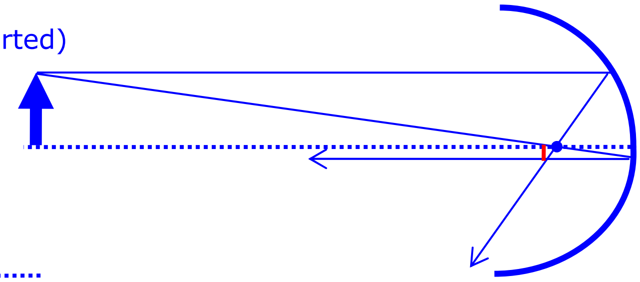
1. An object (height =1.5 cm) is viewed through a concave spherical mirror (f=5 cm). Determine the location, height and orientation of the image for the following distances the object is held away from the lens. Verify your calculations using crude ray diagrams.

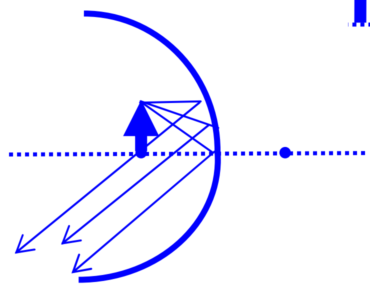
   a. p = 35 cm?

Ans. i = 5.8 cm, m = -0.17, h_i = -0.25 cm (real, inverted)



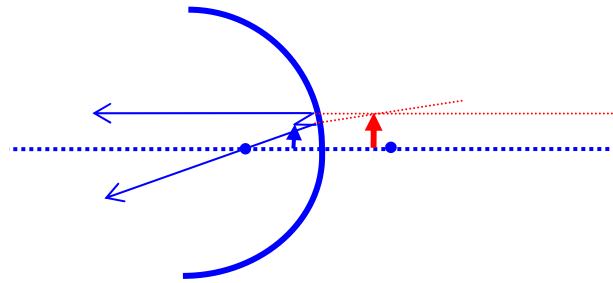
   b. p = 5 cm?

Ans. i = ∞, m = n/a, h_i = n/a



   c. p = 2 cm?

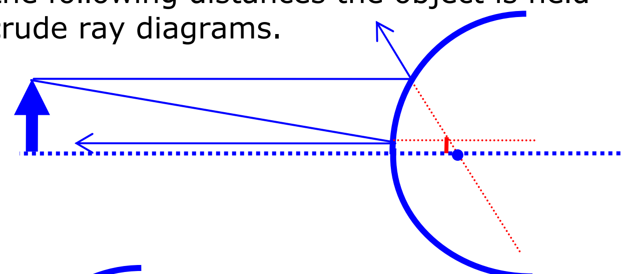
Ans. i = -3.3 cm, m = -1.7, h_i = -2.6 cm (upright)



2. An object (height = 2 cm) is viewed through a convex spherical mirror (f = -10 cm). Determine the location and height of the image for the following distances the object is held away from the lens. Verify your calculations using crude ray diagrams.

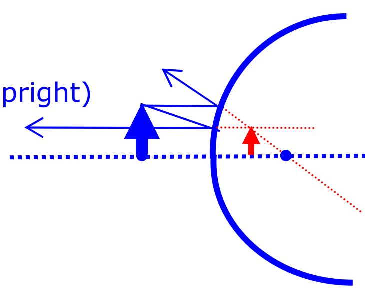
   a. p = 35 cm?

Ans. i = -7.8 cm, m = .22, h_i = .44 cm (upright)



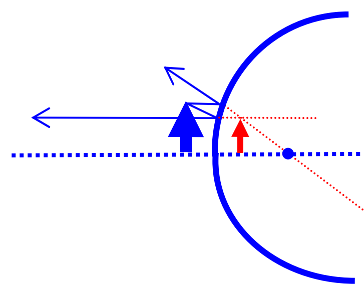
   b. p = 10 cm?

Ans. i = -5 cm, m = 0.5, h_i = 1 cm (upright)



   c. p = 5 cm?

Ans. i = -3.3 cm, m = 0.66, h_i = 1.3 cm (upright)



3. A convex rearview mirror has a radius of curvature of 16.0 m.

   a. Determine the location of the image and its magnification for an object 10.0 m from the mirror.

Ans. i = -4.4 m, m = .66 {caution, objects appear closer than they are…}

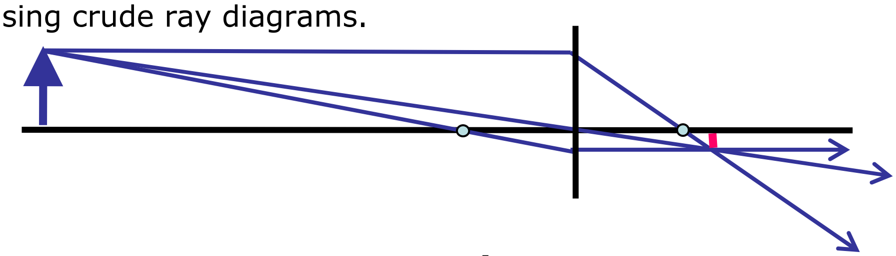
   b. How tall does a car (height = 1.6 m) appear through the rearview mirror when it is 10.0 m from the mirror?

Ans. h_i = 0.70 m

4. An object (height=10 cm) is viewed through a <u>converging</u> lens (f=10 cm). Determine the location and height of the image for the following distances the object is held away from the lens. Verify your calculations using crude ray diagrams.

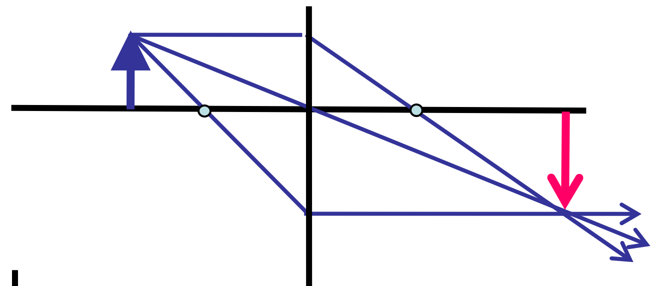
   a. p = 35 cm?

Ans. i = 14 cm, h_i = -4 cm



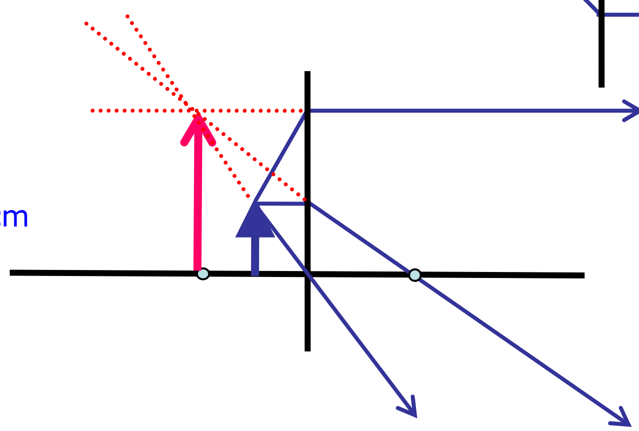
   b. p = 15 cm?

Ans. i = 30 cm, h_i = -20 cm



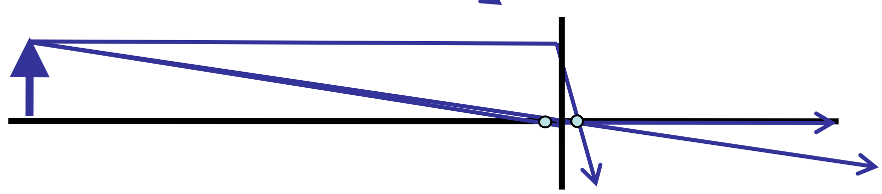
   c. p = 5 cm?

Ans. i = -10 cm, h_i = 20 cm



   d. p = 20 m?

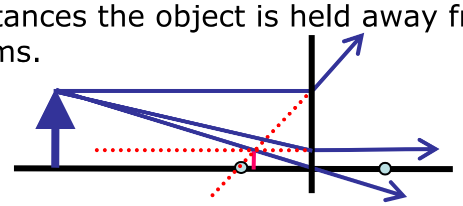
Ans. i = 10.1 cm, h_i = 0.05 cm



5. An object (height=10 cm) is viewed through a <u>diverging</u> lens (f=10 cm). Determine the location and height of the image for the following distances the object is held away from the lens. Verify your calculations using crude ray diagrams.

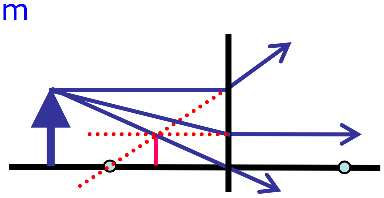
   a. p = 35 cm?

Ans. i = -7.8 cm, h_i = 2.2 cm



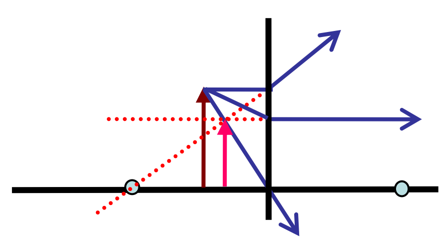
   b. p = 15 cm?

Ans. i = -6 cm, h_i = 4 cm



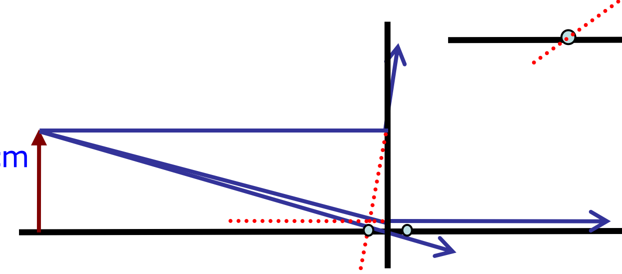
   c. p = 5 cm?

Ans. i = -3.3 cm, h_i = 6.7 cm



   d. p = 20 m?

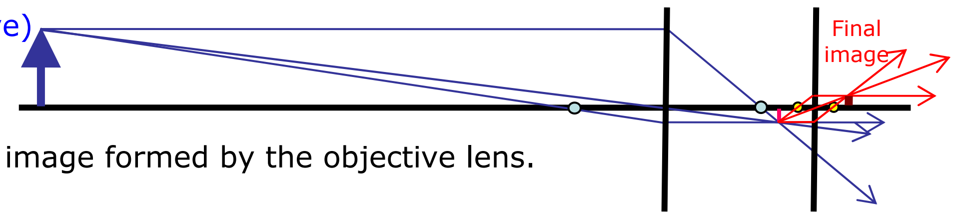
Ans. i = -10.0 cm, h_i = -0.05 cm



6. An object (height =10 cm) is viewed through an optical device containing 2 converging lens separated by 35 cm. For this device, the objective lens has a focal length of 20 cm and the eyepiece has a focal length of 5 cm. If the object is located 500 cm away from the objective: determine the location and height of the final image for the following distances the object is held away from the lens. Verify your calculations using crude ray diagrams.

   a) Determine the location of the image formed by the objective lens.

Ans. i = 20.8 cm (right of objective)



   b) Determine the height of the image formed by the objective lens.

Ans. $h_i = -0.42$ cm

   c) Determine the location of the final image from the eyepiece and the objective, respectively.

Ans. i = 7.7 cm (right of eyepiece)

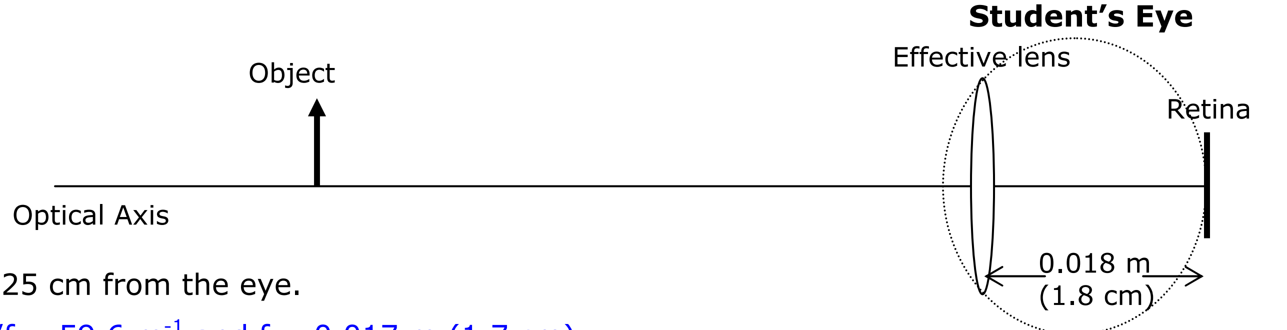
   d) Determine the height of the final image.

Ans. $h_i' = 0.23$ cm

   e) Determine the final magnification of the image.

Ans. $m_{net} = h_i'/h_o = 0.023$

7. Assume that the "effective" lens of the eye is located 1.8 cm from the retina. Determine the focal length and optical power (in diopters) of the eye (lens) when an object is located:



   a) 25 cm from the eye.

Ans. $1/f = 59.6\ m^{-1}$ and $f = 0.017$ m (1.7 cm)

   b) 30 m from the eye.

Ans. $1/f = 55.6\ m^{-1}$ and $f = 0.018$ m (1.8 cm)

   c) 1000 m from the eye.

Ans. $1/f = 55.6\ m^{-1}$ and $f = 0.018$ m (1.8 cm)

8. A particular far-sighted person has a near point of 100 cm. This person wears reading glasses to read a newspaper at a distance of 25 cm. Determine the focal point of the reading glasses and the lens power.

Ans. $$\left(\frac{1}{f}\right)_{correction} = \left(\frac{1}{f}\right)_{@\ 25\ cm} - \left(\frac{1}{f}\right)_{@\ 100\ cm} = \frac{1}{0.25\ m} - \frac{1}{1.00\ m} = +3.0\ m^{-1}\ \text{(diopters)}$$

9. A nearsighted person has near and far points of 12 cm and 17 cm, respectively.

a) What focal length and lens power of corrective eyeglasses are needed for this person to see distant objects clearly? Assume that the lens distance is 2 cm from the eye.

Ans. The role of eyeglasses is to project the image of an object (at infinity) at the eye's far point. It should be noted that eyeglasses sit about 2 cm in front of the lens of the eye, so this must also be taken into account ($p = \infty$ and $i = 17\text{cm} - 2\text{ cm} = 15\text{ cm}$).

$$\left(\frac{1}{f}\right)_{correction} = \frac{1}{\infty} + \frac{1}{-0.15\text{ m}} = \frac{1}{\infty} - \frac{1}{0.15\text{ m}} = -6.7\text{ m}^{-1}\text{ (diopters)}$$

b) What will be the near point for the person with this vision correction?

Ans. First, determine the person's effective (corrected) optical power (for distance vision), using the thin-lens equation:

$$\left(\frac{1}{f}\right)_{corrected} = \frac{1}{\infty} + \frac{1}{0.018\text{m}} = +55.6\text{ m}^{-1}$$

Now, determine person's ability to accommodate during reading:

$$\left(\frac{1}{f}\right)_{accomodation} = \left(\frac{1}{f}\right)_{near} - \left(\frac{1}{f}\right)_{relaxed} = \frac{1}{0.12\text{m}} - \frac{1}{0.17\text{m}} = +2.45\text{ m}^{-1}\text{ (diopters)}$$

The near point with corrected distance vision is now:

$$\left(\frac{1}{p}\right)_{min} = \left(\frac{1}{f}\right)_{effective} - \frac{1}{i} = \left(\frac{1}{f}\right)_{corrected} + \left(\frac{1}{f}\right)_{accomodation} - \frac{1}{i}$$

$$\left(\frac{1}{p}\right)_{min} = +55.6\text{m}^{-1} + 2.45\text{m}^{-1} - \frac{1}{0.018\text{m}} = 2.49\text{ m}^{-1}$$

$$\text{Near Point} = p_{min} = \frac{1}{2.49\text{m}^{-1}} = 0.40\text{ m (40 cm)}$$

c) If the same person were to wear corrective contact lenses, what focal length and lens power would be needed for this person to see distant objects clearly?

Ans. Since contact lenses reside against the eye, you do not need to adjust the object distance by 2 cm, therefore:

$$\left(\frac{1}{f}\right)_{correction} = \left(\frac{1}{f}\right)_{@\ \infty} - \left(\frac{1}{f}\right)_{@\ 17\text{ cm}} = \frac{1}{\infty} - \frac{1}{0.17\text{ m}} = -5.9\text{ m}^{-1}\text{ (diopters)}$$

d) What will be the near point for the person with this vision correction?

Ans. Since the effective focal length and optical power of the person's eye is the same as for eyeglasses, the near point only depends on the eye's accommodative ability (which will not be different from above). Therefore the near point will be the same as above, 40 cm.