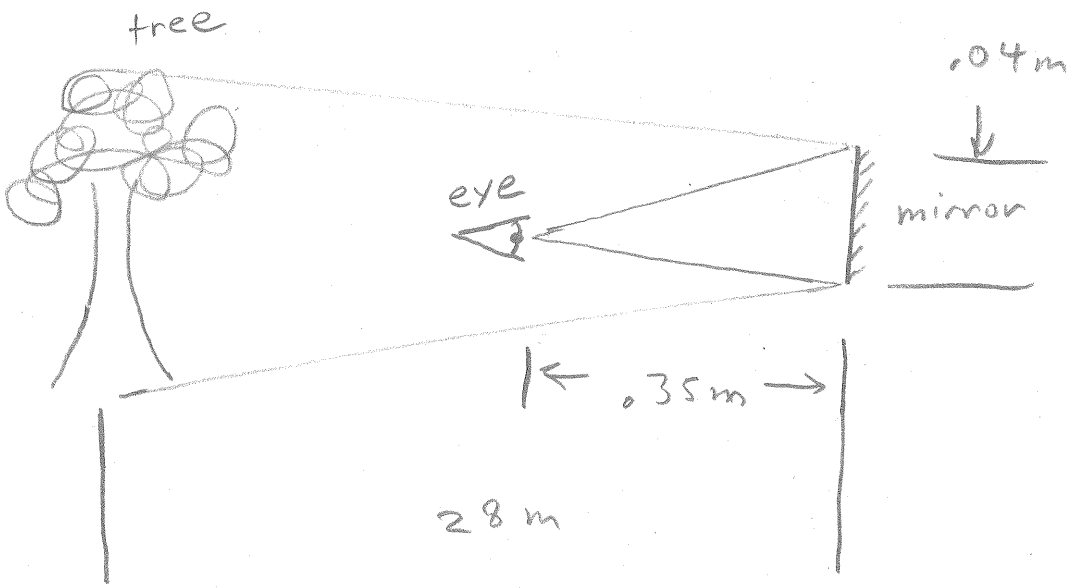
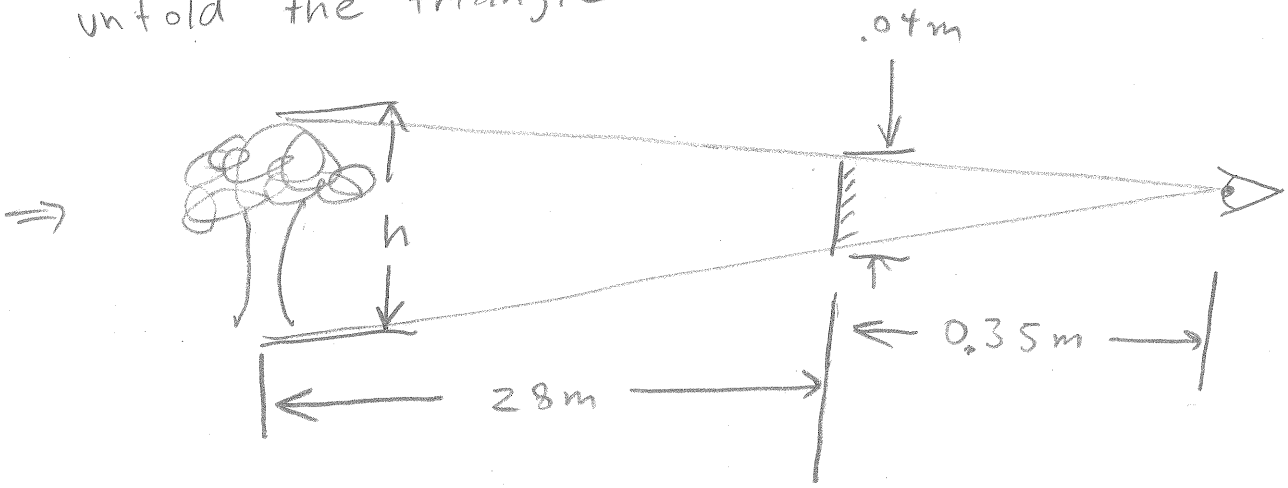
HW 26 From Text

34.2 The image of a tree just covers the length of a plane mirror 4.00 cm tall when the mirror is held 35.0 cm from the eye. The tree is 28.0 m from the mirror. What is its height?



unfold the triangle



By simular triangles

$$\frac{h}{(28m + 0.35m)} = \frac{0.04m}{0.35m} \Rightarrow h = (28.35m)\frac{.04}{.35}$$

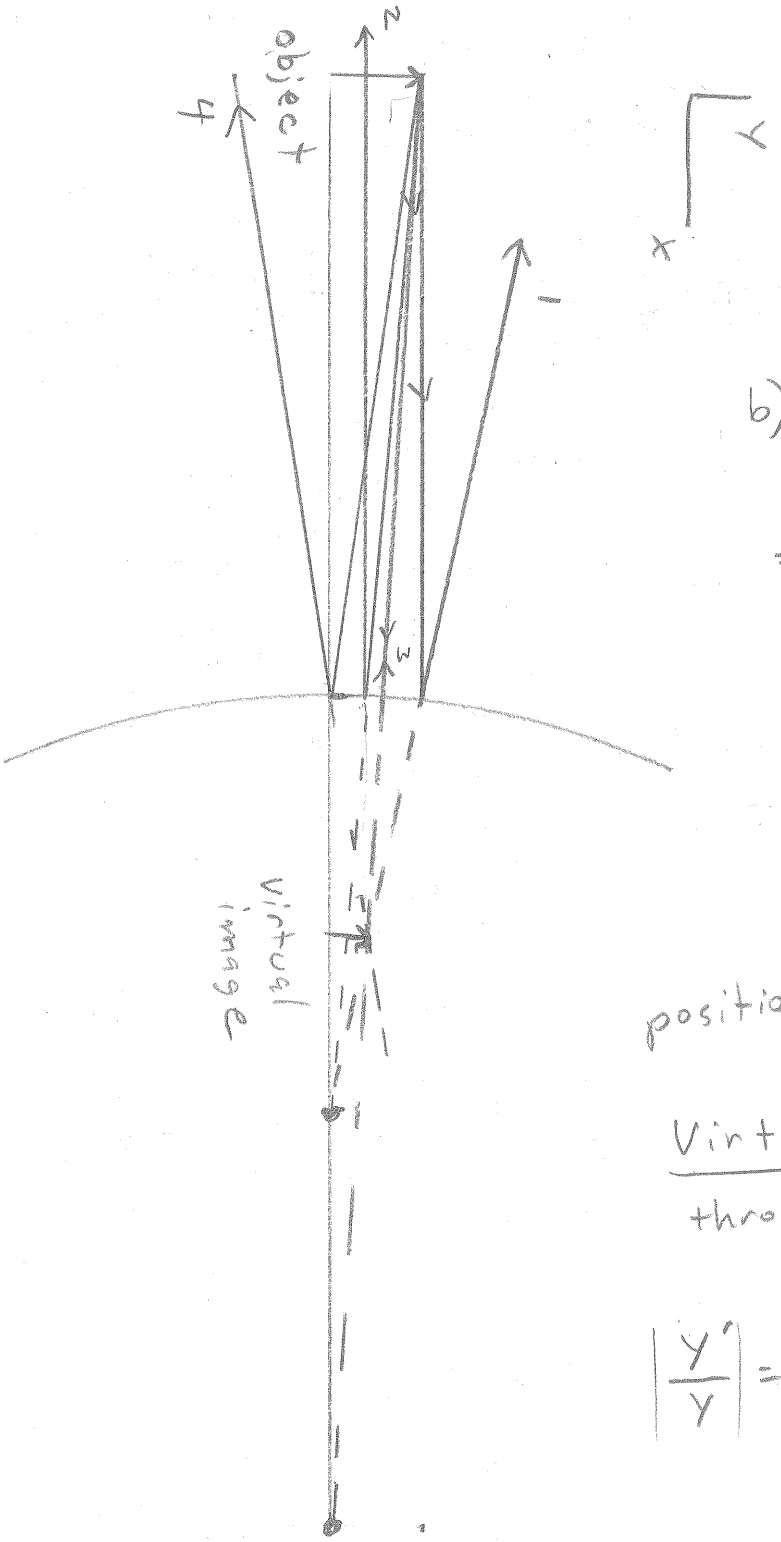
$$= \boxed{3.24\,m}$$

34.6 requires 34.5

34.5 An object 0.600 cm tall is placed 16.5 cm to the left of the vertex of a concave spherical mirror having a radius of curvature of 22.0 cm. a) Draw a principal-ray diagram showing formation of the image. b) Determine the position, size, orientation, and nature (real or virtual) of the image.

34.6 Repeat Exercise 34.5 for the case in which the mirror is convex.

a)



1/2 scale in x
2 scale in y

b) $\frac{1}{s} + \frac{1}{s'} = -\frac{2}{R}$

$\Rightarrow \frac{1}{s'} = -\frac{2}{R} - \frac{1}{s}$

$s' = \frac{1}{-\frac{2}{R} - \frac{1}{s}}$

$= \frac{1}{-\frac{2}{(22\text{cm})} - \left(\frac{1}{16.5\text{cm}}\right)}$

position $s = \boxed{-6.6\text{ cm}}$ from mirror to right

Virtual no rays pass through it.

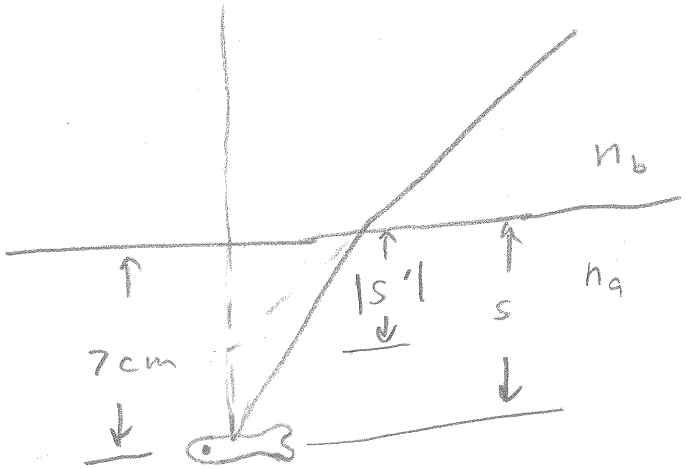
$\left|\frac{y'}{y}\right| = \left|\frac{s'}{s}\right| \Rightarrow y' = .6\text{ cm}\ \frac{6.6\text{ cm}}{16.5\text{cm}}$

$= \boxed{0.24\text{ cm}}$

upright

34.16 A tank whose bottom is a mirror is filled with water to a depth of 20.0 cm. A small fish floats motionless 7.0 cm under the surface of the water. a) What is the apparent depth of the fish when viewed at normal incidence? b) What is the apparent depth of the image of the fish when viewed at normal incidence?

a)

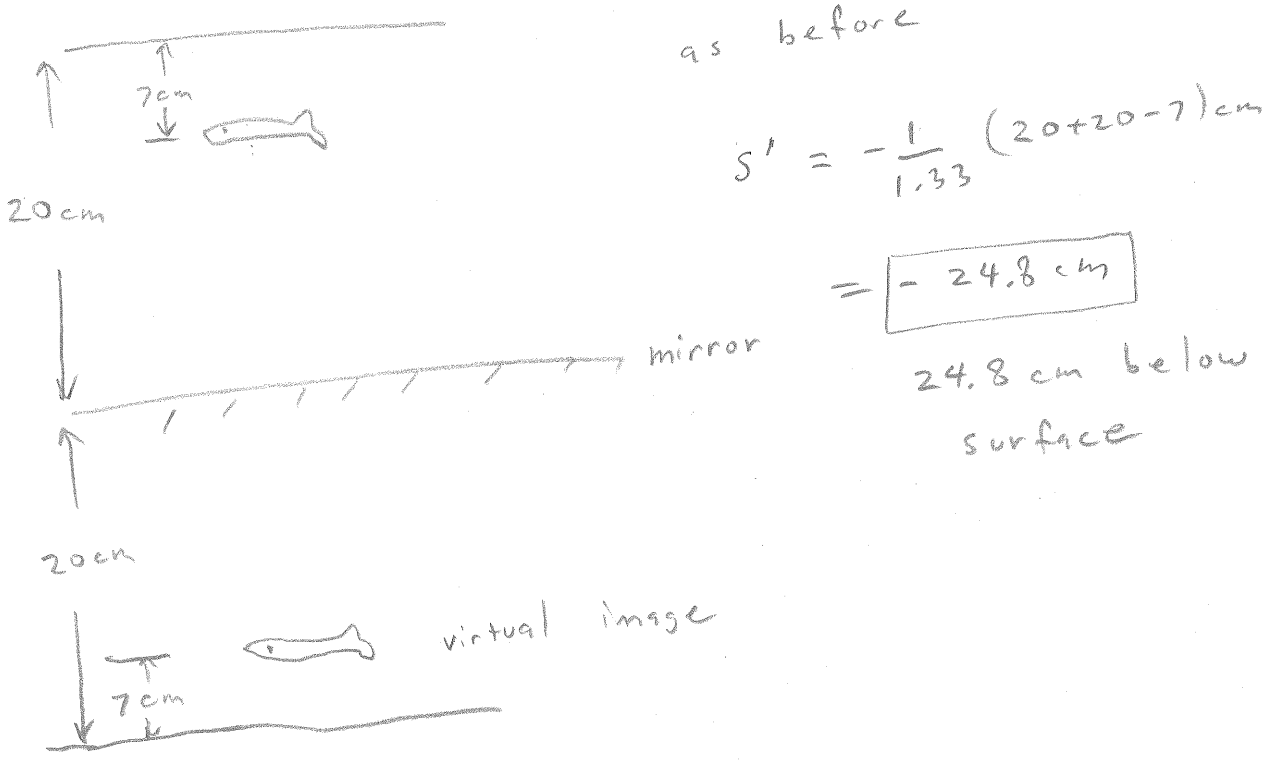


$$\frac{n_a}{s} + \frac{n_b}{s'} = \frac{n_b - n_a}{R} = 0 \Rightarrow s' = -\frac{n_b}{n_a} s = \frac{-1}{1.33} 7\text{cm}$$

$$= \boxed{-5.26\text{ cm}}$$

5.26 cm below surface

b)



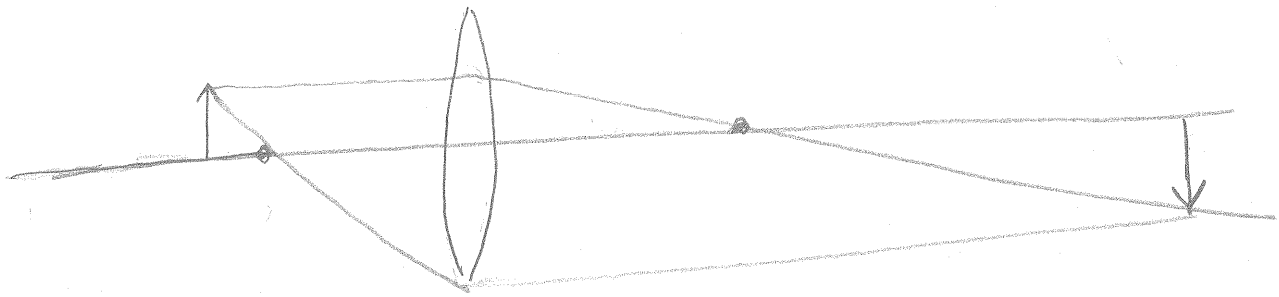
as before

$$s' = -\frac{1}{1.33}(20+20-7)\text{cm}$$

$$= \boxed{-24.8\text{ cm}}$$

24.8 cm below surface

34.26 A converging lens with a focal length of 90.0 cm forms an image of a 3.20-cm-tall real object that is to the left of the lens. The image is 4.50 cm tall and inverted. Where are the object and image located in relation to the lens? Is the image real or virtual?



$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

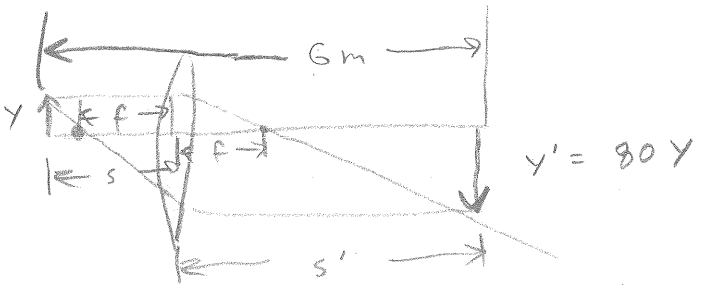
$$\frac{s'}{s} = -\frac{y'}{y} \Rightarrow s' = -s\frac{y'}{y} \Rightarrow \frac{1}{s} - \frac{y}{sy'} = \frac{1}{f}$$

$$\Rightarrow \frac{1}{s}\left(1 - \frac{y}{y'}\right) = \frac{1}{f} \Rightarrow s = f\left(1 - \frac{y}{y'}\right) = 90\text{cm}\left(1 - \frac{3.2}{-4.5}\right)$$

$$s = \boxed{154\text{ cm}} \qquad s' = -154\text{cm}\left(-\frac{4.5}{3.2}\right) = \boxed{216.6\text{ cm}}$$

The image is real.

34.28 A photographic slide is to the left of a lens. The lens projects an image of the slide onto a wall 6.00 m to the right of the slide. The image is 80.0 times the size of the slide. a) How far is the slide from the lens? b) Is the image erect or inverted? c) What is the focal length of the lens? Is the lens converging or diverging?



$$\frac{s}{s'} = -\frac{y}{y'} = \frac{1}{80} \Rightarrow s = \frac{1}{80}s'$$

$$\Rightarrow s + s' = 6m \Rightarrow s + 80s = 6m \Rightarrow s = \frac{6m}{81}$$

$$\Rightarrow s = \boxed{7.41\,cm}$$

b) inverted

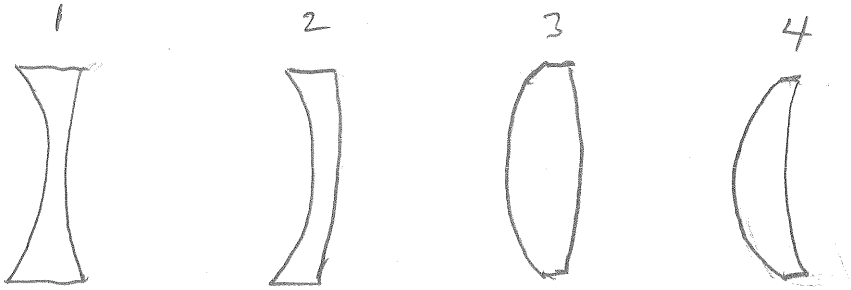
c) $\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \Rightarrow f = \frac{1}{\frac{1}{s} + \frac{1}{s'}} = \frac{1}{\frac{1}{7.41074_{cm}} + \frac{1}{80(7.41}}$

$$\Rightarrow f \cong \boxed{7.32\,cm}$$

converging

34.29 Sketch the various possible thin lenses that can be obtained by combining two surfaces whose radii of curvature are 4.00 cm and 8.00 cm in absolute magnitude. Which are converging and which are diverging? Find the focal length of each if the surfaces are made of glass with index of refraction 1.60.

not to scale



$$f = \frac{1}{(n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)} = \frac{1}{(.6)\left(\frac{1}{\pm 4\,cm} - \frac{1}{\pm 8\,cm}\right)}$$

$$\Rightarrow \quad f_1 = (- -) = -4.44\,cm$$

$$f_2 = (- +) = -13.3\,cm$$

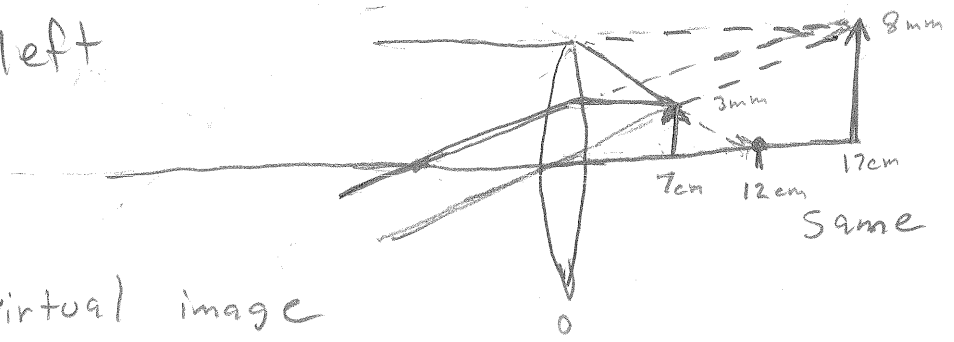
$$f_3 = (+ -) = +4.44\,cm$$

$$f_4 = (+ +) = +13.3\,cm$$

34.32 A converging lens with a focal length of 12.0 cm forms a virtual image 8.00 mm tall, 17.0 cm to the right of the lens. Determine the position and size of the object. Is the image erect or inverted? Are the object and image on the same side or opposite sides of the lens? Draw a principal-ray diagram for this situation.

right

left



same side

Virtual image

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \Rightarrow \frac{1}{s} = \frac{1}{f} - \frac{1}{s'} \Rightarrow s = \frac{1}{\frac{1}{f} - \frac{1}{s'}}$$

$$= \frac{1}{\frac{1}{12\text{cm}} - \frac{1}{-17\text{cm}}} \Rightarrow s = \boxed{7.0345\text{cm}}$$

$$m = -\frac{s'}{s} = -\frac{-17\text{cm}}{7.0345\text{cm}} = \boxed{2.41}$$

$$y = \frac{y'}{m} = \frac{0.8\text{cm}}{2.41} = \boxed{.331\text{cm}}$$