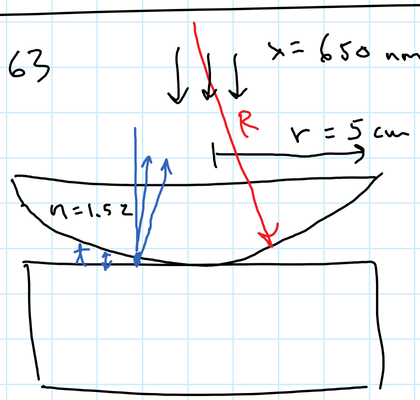
Phy 4C 3/20

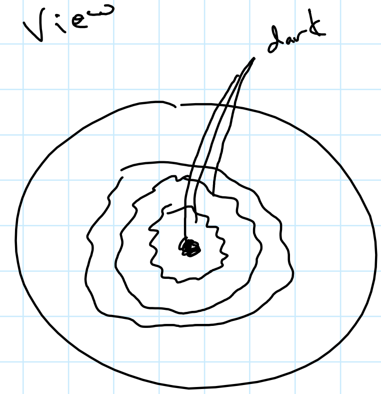
Monday, March 20, 2017 10:51 AM

Review:

- Newton's Rings
- Misc. Problems
- Speed of sound demonstration

Book Prob 37-63





55 bright fringes are observed

Find R

Path difference + phase shifts = integer mult. of λ for constructive (bright spot)

$$2t + \frac{\lambda}{2} = m\lambda$$

$m = 1, 2, 3, \ldots, 55$

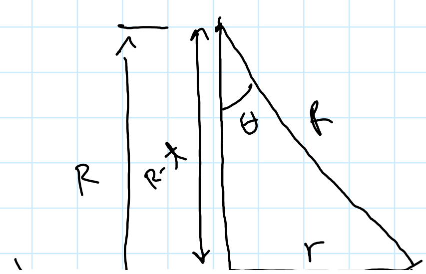
↑ 1st bright fringe ... ↑ 55th bright fringe

$$2t = \left(55 - \tfrac{1}{2}\right)\lambda_{film}$$

↑ in air

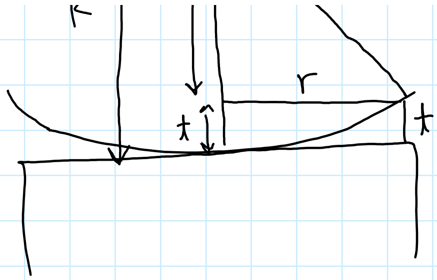
$$2t = 54.5\,(650\text{ nm})$$

$$t = 1.77 \times 10^{-5}\text{ m}$$



$$R - R\cos\theta = t$$

and



and

$$\sin\theta = \frac{r}{R}$$

R & θ are the two unknowns

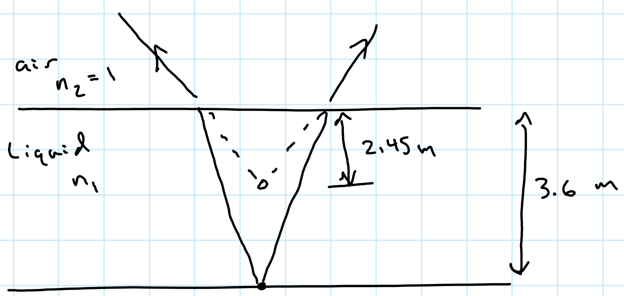
OR,

$$(R-t)^2 + r^2 = R^2$$

$$R^2 - 2Rt + t^2 + r^2 = R^2$$

$$R = \frac{t^2 + r^2}{2t} = 70.6 \text{ m}$$

34.18 • A transparent liquid fills a cylindrical tank to a depth of 3.60 m. There is air above the liquid. You look at normal incidence at a small pebble at the bottom of the tank. The apparent depth of the pebble below the liquid's surface is 2.45 m. What is the refractive index of this liquid?



$$\frac{n_1}{p} + \frac{n_2}{q} = \frac{n_2 - n_1}{R}$$

$$\frac{n_1}{3.6} + \frac{1}{-2.45} = \frac{1-n_1}{\infty} \to 0$$

$$n_1 = \frac{3.6}{2.45} = 1.47$$

34.41 •• Combination of Lenses I. A 1.20-cm-tall object is 50.0 cm to the left of a converging lens of focal length 40.0 cm. A second converging lens, this one having a focal length of 60.0 cm, is located 300.0 cm to the right of the first lens along the same optic axis. (a) Find the location and height of the image (call it I_1) formed by the lens with a focal length of 40.0 cm. (b) I_1 is now the object for the second lens. Find the location and height of the image produced by the second lens. This is the final image produced by the combination of lenses.

Calculations 1st

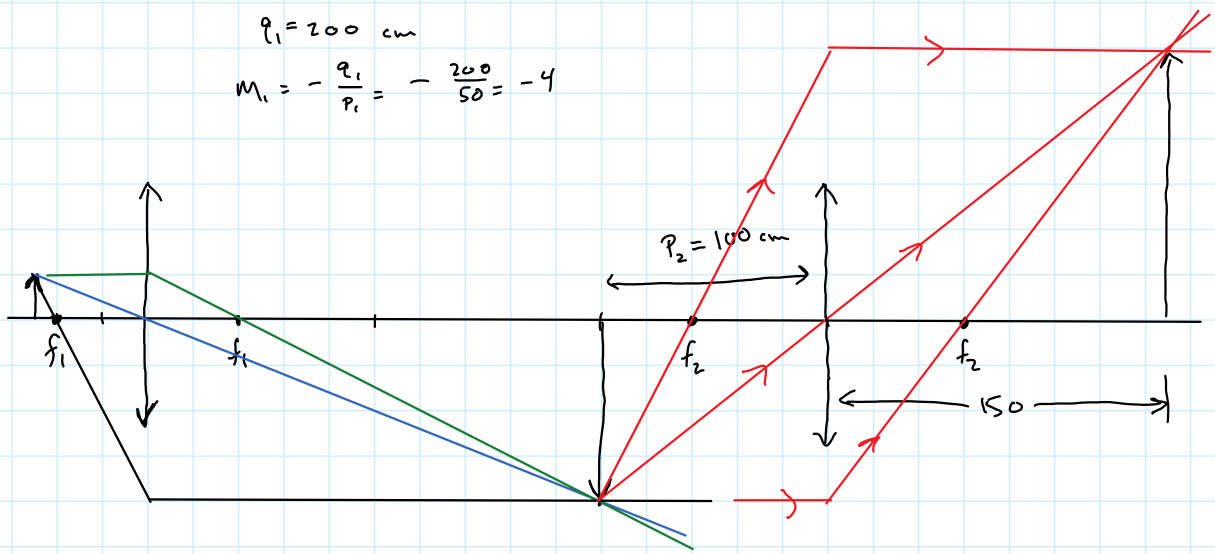
Find q_1 (image from lens 1)

$$\frac{1}{p_1} + \frac{1}{q_1} = \frac{1}{f_1}$$

$$\frac{1}{50} + \frac{1}{q_1} = \frac{1}{40}$$

$$q_1 = 200 \text{ cm}$$

$$M_1 = -\frac{q_1}{p_1} = -\frac{200}{50} = -4$$



Now, Lens 2

$$\frac{1}{p_2} + \frac{1}{q_2} = \frac{1}{f_2}$$

$$\frac{1}{100} + \frac{1}{q_2} = \frac{1}{60}$$

$$q_2 = 150$$

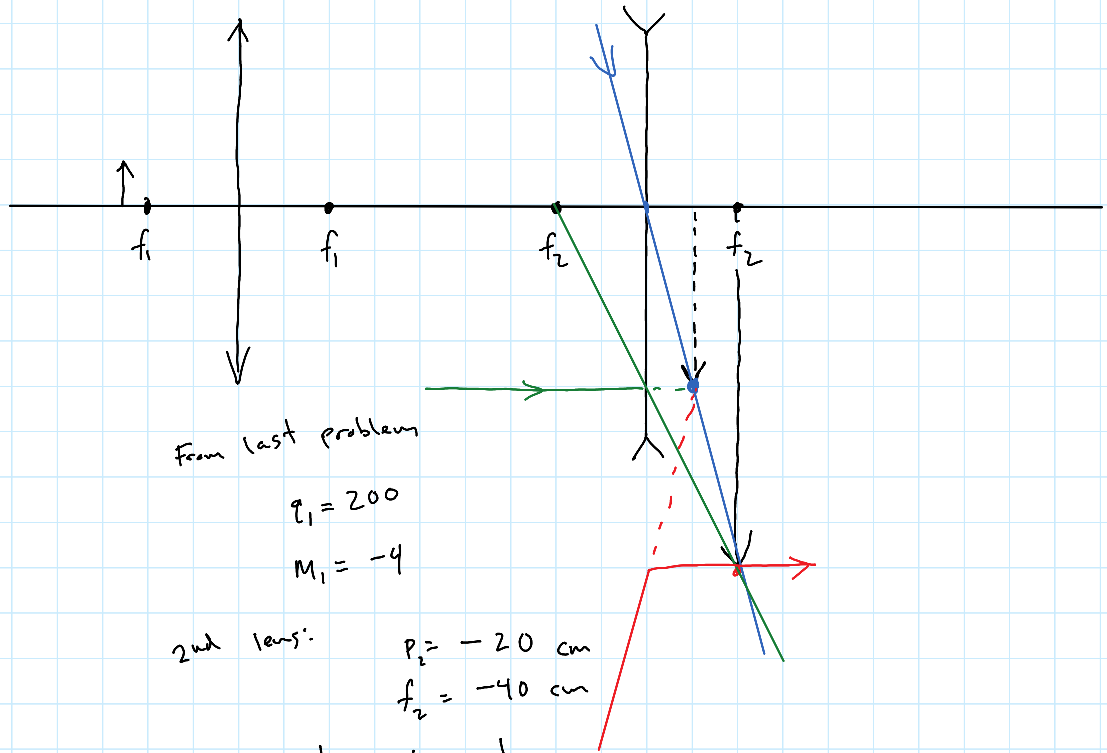
$$M_2 = -\frac{150}{100} = -1.5$$

$$M_{total} = M_1 \times M_2 = (-4)(-1.5) = 6$$

Again, with Lens 2 changed:

Let lens 2 be diverging $f = -40$ cm

located 180 cm to the right of lens 1



From last problem

$q_1 = 200$

$M_1 = -4$

2nd lens: $p_2 = -20$ cm

$f_2 = -40$ cm

$$\frac{1}{-20} + \frac{1}{q} = \frac{1}{-40}$$

$q = +40$ cm

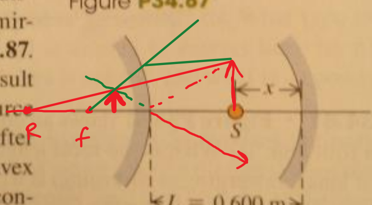
$$M_2 = -\frac{40}{-20} = +2$$

$$M_{total} = (-4)(+2) = -8$$

Real image

34.87 •• A convex mirror and a concave mirror are placed on the same optic axis, separated by a distance $L = 0.600$ m. The radius of curvature of each mirror has a magnitude of 0.360 m. A light source is located a distance x from the concave mirror, as shown in **Fig. P34.87**. (a) What distance x will result in the rays from the source returning to the source after reflecting first from the convex mirror and then from the concave mirror? (b) Repeat part (a), but now let the rays reflect first from the concave mirror and then from the convex one.

Figure **P34.87**



Let $x = 0.2$ m and find location of final image (& Magnification)

a) 1st the convex mirror

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

$$\frac{1}{0.4} + \frac{1}{q_1} = \frac{1}{-0.18}$$

left of convex mirror

$$\frac{1}{0.4} + \frac{1}{q_1} = \frac{1}{-0.18}$$

$q_1 = -0.124$ on left of convex mirror

$$M_1 = -\frac{(-0.124)}{0.4} = +0.31$$

Now, the concave mirror

$$\frac{1}{p_2} + \frac{1}{q_2} = \frac{1}{f_2}$$

$$\frac{1}{0.6+0.124} + \frac{1}{q_2} = \frac{1}{+0.18}$$

$q_2 = 0.24$ on left of concave mirror

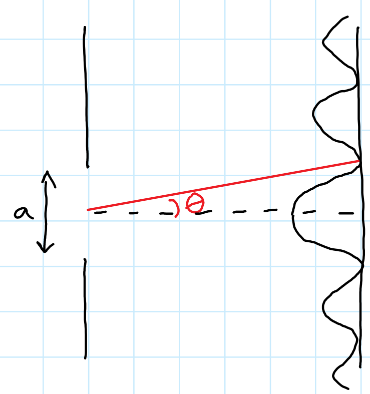
$$M_2 = -\frac{0.24}{0.724} = -0.33$$

$$M_{total} = M_1 \times M_2 = -0.103$$

length of the light?

36.47 •• BIO Thickness of Human Hair. Although we have discussed single-slit diffraction only for a slit, a similar result holds when light bends around a straight, thin object, such as a strand of hair. In that case, *a* is the width of the strand. From actual laboratory measurements on a human hair, it was found that when a beam of light of wavelength 632.8 nm was shone on a single strand of hair, and the diffracted light was viewed on a screen 1.25 m away, the first dark fringes on either side of the central bright spot were 5.22 cm apart. How thick was this strand of hair?

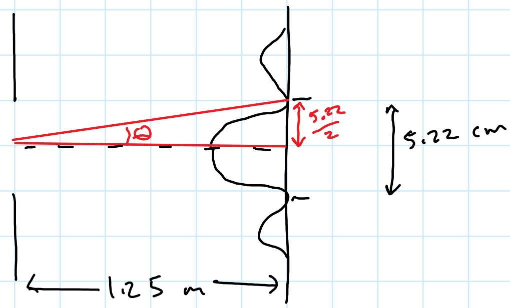
Single slit:



$$\sin\theta_{dark} = m\frac{\lambda}{a}$$

$m = \pm 1, \pm 2, \ldots$

a = slit width



Small angle approx: $\tan\theta \simeq \sin\theta \simeq \theta \simeq \frac{\frac{5.22\times10^{-2}}{2}}{1.25} \simeq 0.0209$

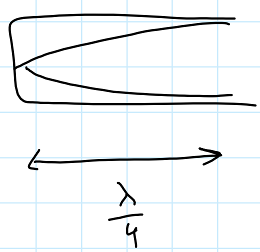
$$\sin\theta = m\frac{\lambda}{a}$$

$$0.0209 = (1)\left(\frac{632.8\ \text{nm}}{a}\right)$$

$$a = 3.03\times10^{-5}\ \text{m}$$

$$= 30.3\ \mu\text{m}$$

Sound



$$v = \lambda f$$