14.15 Given that a ruby laser operating at 694.3 nm has a frequency bandwidth of 50 MHz, what is the corresponding linewidth?

$$c = \lambda \nu$$

$$\lambda = \frac{c}{\nu}$$

$$\frac{d\lambda}{d\nu} = -\frac{c}{\nu^2} = -\frac{c}{\nu} \times \frac{1}{\nu} = -\frac{\lambda}{\nu}$$

$$\frac{c}{\nu^2} = \frac{1}{c}\left(\frac{c}{\nu}\right)^2 = \frac{\lambda^2}{c}$$

$$\frac{\Delta\lambda}{\Delta\nu} = \frac{c}{\nu^2} = \frac{\lambda^2}{c}$$

$$\Delta\lambda = \frac{\lambda^2 \Delta\nu}{c}$$

$$= \frac{(694.3)^2 \times 10^{-18} * 50 \times 10^6}{3 \times 10^8}$$

$$= 8.03 \times 10^{-5} \text{ nm}$$

14.16 Determine the frequency difference between adjacent axial resonant cavity modes for a typical gass laser 25 cm long ($n = 1$).

$$L = \frac{m \lambda_m}{2}$$

$$f_m = \frac{c}{\lambda_m}$$

$$\lambda_m = \frac{2L}{m}$$

$$f_m = \frac{c}{\lambda_m} = \frac{mc}{2L}$$

$$\Delta f = f_{m+1} - f_m = \frac{c}{2L} = \frac{3 \times 10^8}{50 \times 10^{-2}}$$

$$\Delta f = \frac{3 \times 10^8}{.5} = 6 \times 10^8 = 600 \text{ MHz}$$

L.1 A He-Ne laser beam with an angle of divergence of 0.5 mrad is fucused to a spot using a convex lens with a 5 cm focal length. What is the diameter of the spot?

$$D = f\phi_1 = 5 \times 10^{-2} * 0.5 \times 10^{-3} = 2.5 \times 10^{-5}\ m$$

$$D = .025\ mm$$

L.2 The beam expander shown in Figure 2 is used to expand a laser beam with a diameter of 1.2 mm a 0.80 mrad angle of divergence. f_1 = 1.2.cm. f_2 = 18.0 cm.

a. What is the diameter of the beam produced by the expander?

b. What is the resulting divergence angle of the beam?

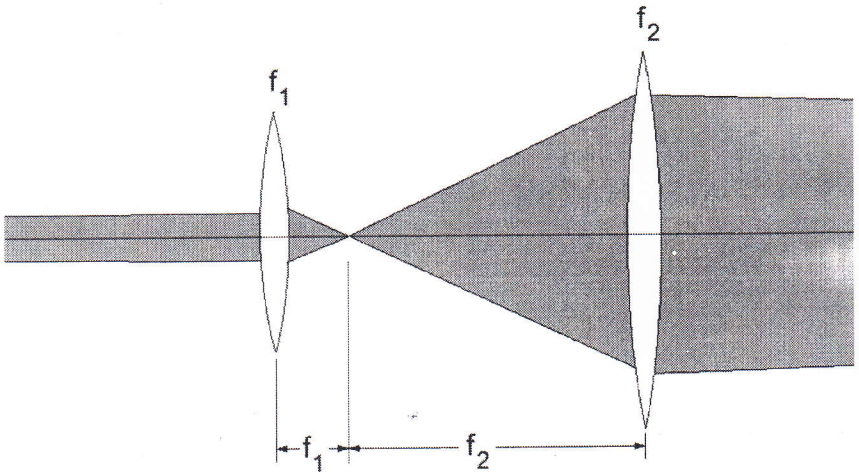

Figure 2

$$D_2 = \frac{f_2}{f_1} D_1$$

$$= \frac{18}{1.2} * 1.2 = 18\ mm = 1.8\ cm$$

$$\phi_2 = \frac{f_1}{f_2} \phi_1$$

$$= \frac{1.2}{18} * 0.8 = 0.053\ mrad$$

L.3 Design a beam expander that will transform a laser beam with a 0.75 mrad angle of divergence and a 2 mm spot size into a 1.0 cm diameter beam.

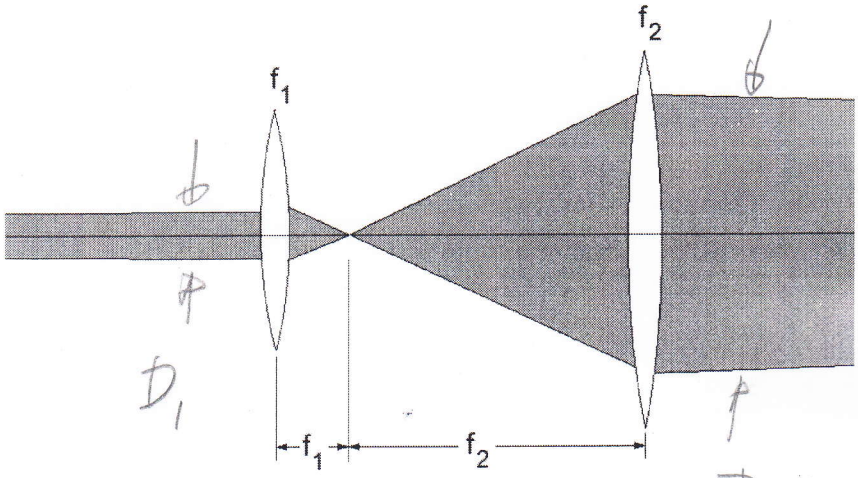

Figure 2

$$D_2 = \frac{f_2}{f_1} D_1$$

$$\frac{f_2}{f_1} = \frac{D_2}{D_1} = \frac{1\,cm}{0.2\,cm} = 5$$

Let $f_2 = 5$ cm

$f_1 = 1$ cm

OTHER VALUES of f_1 & f_2 will work.

AS LONG as $\frac{f_2}{f_1} = 5$