Consider a Gaussian beam whose width (beam radius) $W(z)$ and wavefront radius of curvature $R(z)$ are given by

$$W(z) = W_0 \left(1 + \frac{\lambda^2 z^2}{\pi^2 W_0^2}\right)^{1/2}$$

$$R(z) = z + \frac{\pi W_0^2}{\lambda z^2}$$

Here $\lambda$ is the wavelength and $W_0$ is the beam radius at the center.

(a) (1 points) The axial distance within which the beam width is no greater than $\sqrt{2}$ times its minimum value is known as the depth of focus. For a HeNe wavelength, $\lambda = 633$ nm, calculate a depth of focus for a Gaussian beam with a spot diameter $2\times W_0 = 2$ cm.

For (b), (c) and (d): A symmetrical cavity is formed by two concave spherical mirrors, each of radius of curvature $R$ and separated by a distance $d$.

(b) (1.5 points) Calculate the spot size, $2W_0$, at the center of the cavity, as a function of $R$, $d$, and $\lambda$.

One of the most commonly used cavity configuration is known as the confocal resonator, which consists of two identical concave spherical mirrors with $R = d$.

(c) (0.25 points) What is the advantage of using the confocal cavity compared with a cavity consisting of flat parallel mirrors?

(d) (1.25 points) In the case of a confocal resonator with $R = d$, calculate the spot size at the center and the spot size at either mirror (i.e. $z = \pm d/2$).