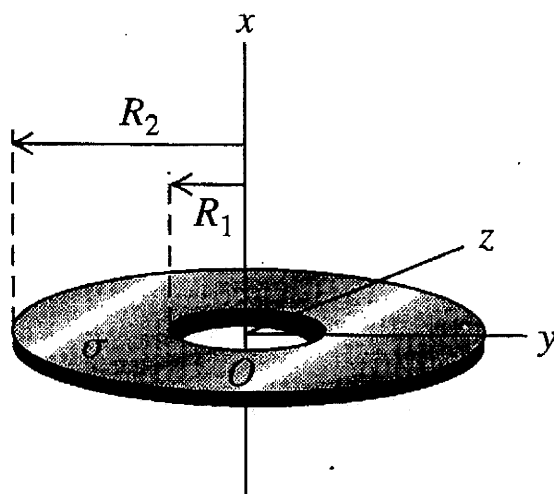


21.104. A thin disk with a circular hole at its center, called an *annulus*, has inner radius R_1 and outer radius R_2 (Fig. 21.51). The disk has a uniform positive surface charge density σ on its surface. (a) Determine the total electric charge on the annulus. (b) The annulus lies in the yz -plane, with its center at the origin. For an arbitrary point on the x -axis (the axis of the annulus), find the magnitude and direction of the electric field \vec{E} . Consider points both above and below the annulus in Fig. 21.51. (c) Show that at points on the x -axis that are sufficiently close to the origin, the magnitude of the electric field is approximately proportional to the distance between the center of the annulus and the point. How close is “sufficiently close”? (d) A point particle with mass m and negative charge $-q$ is free to move along the x -axis (but cannot move off the axis). The particle is originally placed at rest at $x = 0.01R_1$ and released. Find the frequency of oscillation of the particle. (*Hint:* Review Section 13.2. The annulus is held stationary.)

Figure 21.51
Problem 21.104.



HINT: We did a similar example in class. Make use of those results.