Exercises to accompany section 16-8, Gauss' Law

1. Figure 16.8D is a two-dimensional view of three point charges and three volumes (two spheres and one cube) that enclose one or more of the point charges. Rank the volumes, from most positive to most negative, based on the net charge they enclose.

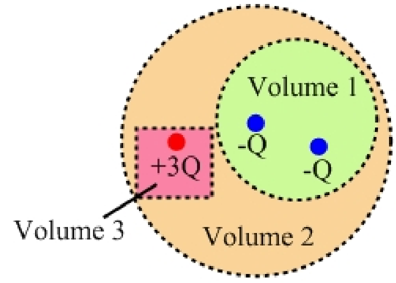

Figure 16.8D: A two-dimensional representation of a region in which there are three point charges and three volumes (two spheres and a cube), for Exercise 1.

2. Figure 16.8E shows a two-dimensional view of a small ball of charge –Q that is at the common center of two spherical volumes. Volume 1 has a larger radius than volume 2. Rank these volumes, from largest to smallest, based on (a) the net charge they enclose, and (b) the magnitude of the electric field at their surfaces.

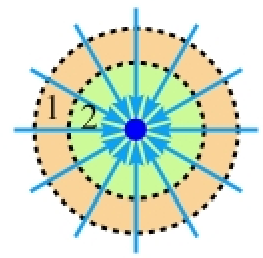

Figure 16.8E: A two-dimensional representation of a negatively charged ball at the center of two enclosing spheres, for Exercise 2.

3. Figure 16.F is a two-dimensional view of a region of space in which the electric field is uniform, with a magnitude of 200 N/C, and a cube with sides measuring 20 cm. Note that, when applying the special form of Gauss' law given in Equation 16.5, the product of *A* and *E* is non-zero for a surface only when some field passes through that surface. (a) Considering the six sides of the cube, how many have a non-zero product of *A* and *E*? (b) What is the magnitude of the product of *A* and *E* for each of the remaining sides? (c) Explain how we can apply Equation 16.5 in this case to prove that the cube contains no net charge.

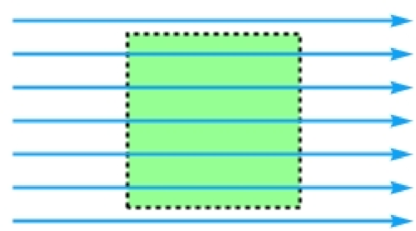

Figure 16.8F: A two-dimensional representation of a uniform electric field passing through a cubical volume, for Exercise 3.

4. Figure 16.G shows a perspective view of a small section of a very long straight line, which has positive charge spread uniformly along it. The arrows show the form of the electric field emanating from this charged line at one point – the field emanating from all other points on the line is the same. If you were to apply Equation 16.5 to determine the magnitude of the electric field at some point a distance r from the line of charge, would you use (a) a spherical volume, (b) a cubical volume, or (c) a cylindrical volume? Explain your answers in each case.

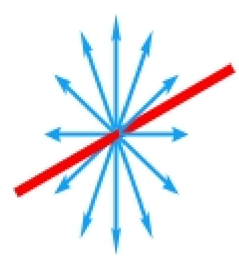

Figure 16.8G: A section of a uniformly charged line, and the electric field lines that emanate from the line at one point, for Exercises 4 and 5.

5. Return to the situation described in Exercise 4. If every meter of the line has a total charge of +3.0 μC, apply Equation 16.5 to determine the magnitude of the electric field at a point 2.0 m from the line. Use the appropriate shape for the enclosing volume, as determined in Exercise 4.