Problems

Chapter 3

1. Each side of the cube shown below is $a = 2.00$m. Find the following.

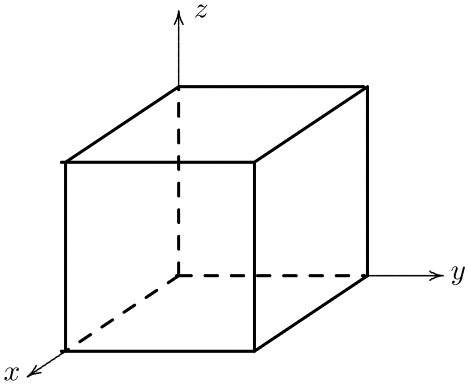
   (a) The flux through the front face for the electric field $\vec{\mathbf{E}} = 5.00\hat{\mathbf{k}}$N/C.

   (b) The flux through the right face for the electric field $\vec{\mathbf{E}} = 5.00\hat{\mathbf{j}}$N/C.

   (c) The flux through the top face for the electric field $\vec{\mathbf{E}} = 5.00\hat{\mathbf{k}}$N/C.

   (d) The flux through the front face for the electric field $\vec{\mathbf{E}} = 2.00\hat{\mathbf{i}} + 4.00\hat{\mathbf{j}} - 5.00\hat{\mathbf{k}}$N/C.

   (e) The total flux through all faces for the electric field $\vec{\mathbf{E}} = 2.00\hat{\mathbf{i}} + 4.00\hat{\mathbf{j}} - 5.00\hat{\mathbf{k}}$N/C.



2. Find the total flux over a spherical surface of radius 5.00m due to a point charge of 2.00μC placed at the center. How would the flux change if the sphere were replaced by a cube of side 5.00m?

3. For the cubical surface shown in problem 1, find the total flux and enclosed charge for each of the following electric fields.

   (a) $\vec{\mathbf{E}} = 2.00x\hat{\mathbf{i}}$N/C.

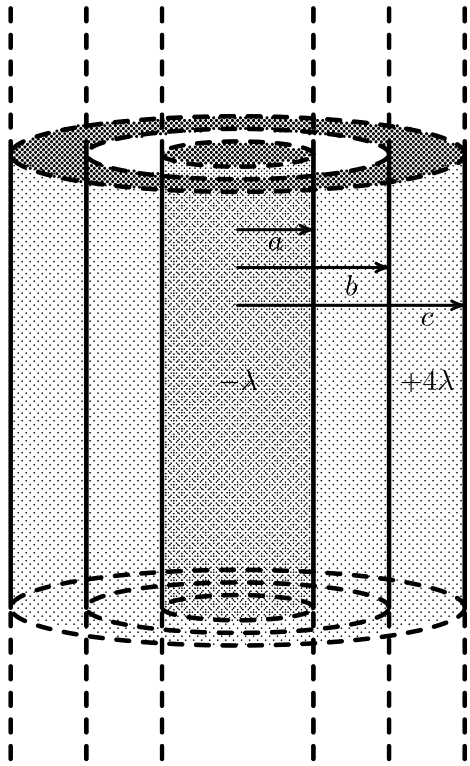
   (b) $\vec{\mathbf{E}} = 2.00x\hat{\mathbf{i}} + 5.00\hat{\mathbf{j}}$N/C.

4. A long conducting cylindrical rod of radius a has a uniform charge per unit length of $-\lambda$. The rod is surrounded by a conducting cylindrical shell of inner radius b and outer radius c (with the same axis as the rod). A uniform charge per unit length of $+4\lambda$ is placed on the shell. The figure below shows the arrangement. It is somewhat like a coaxial cable. Although the charges are given per unit length along the axis, note that they are spread uniformly over the surfaces as Gauss' law requires under static conditions. Find the following for static conditions.

   (a) The electric field outside the shell ($r > c$).

   (b) The distribution of charge on the shell (charge on the inner ($r = b$) and outer($r = c$) surfaces).

   (c) The electric field in the region between the rod and the shell ($a < r < b$).

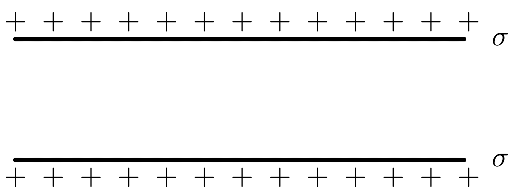


5. The figure below shows the side view of two large plates placed parallel to each other. Each has a uniform positive surface charge density of σ. Find the resulting electric field

   (a) above both plates,

   (b) between the two plates,

   (c) below both plates.



6. Two large parallel plates are oppositely charged with uniform surface charge densities σ and $-\sigma$. The distance between the plates is d. A point particle of positive charge q and mass m is released from rest at the positive plate. Find the time taken by the particle to reach the negative plate. You may ignore gravity.

7. The figure below shows a nonconducting solid sphere of radius a with a charge q uniformly spread throughout its volume. It is surrounded by a conducting concentric spherical shell of inner radius b and outer radius c. A charge of $2q$ is placed on the shell. The system is under static conditions. Assume q to be positive.

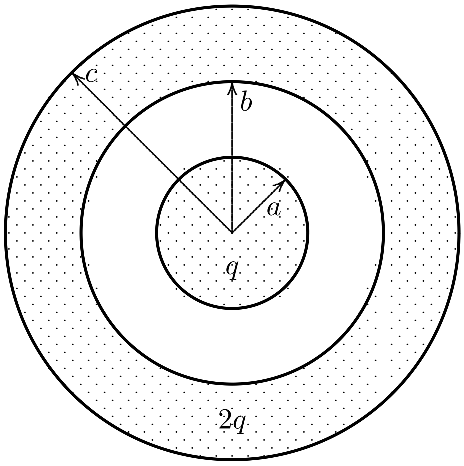
   (a) Find the electric field inside the solid sphere at a distance r from the center ($r < a$).

   (b) Find the electric field between the solid sphere and the shell at a distance r from the center ($a < r < b$).

(c) Find the electric field within the shell a distance r from the center ($b < r < c$).

(d) Find the electric field outside the shell a distance r from the center ($r > c$).

(e) Find the distribution of charge on the shell.



8. The figure below shows a point charge of q at the center of two thin concentric conducting shells of radii a and b ($a < b$). The inner shell of radius a has a charge of $-2q$ and the outer one of radius b has a charge of $4q$. The system is under static condition. Assume q to be positive.

   (a) Find the electric field inside the inner shell at a distance r from the center ($0 < r < a$).

   (b) Find the electric field in between the two shells at a distance r from the center ($a < r < b$).

   (c) Find the electric field outside the outer shell at a distance r from the center ($r > b$).