Problem 1 Two charges are placed as shown in Fig. 1. The magnitude of q_1 is 3.00 µC, but its sign and the value of the charge q_2 are not known. The direction of the net electric field **E** at point P is entirely in the negative y direction.

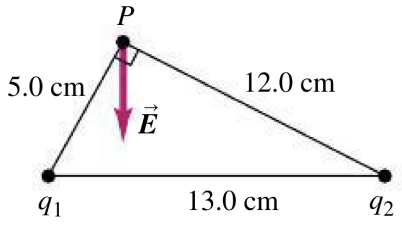

Figure 1

(a) Considering the different possible signs of q_1 and q_2, four possible diagrams could represent the electric fields $\mathbf{E}_1$ and $\mathbf{E}_2$ produced by q_1 and q_2. Sketch the four possible electric field configurations.

(b) Using the sketches from part (a) and the direction of **E**, deduce the signs of q_1 and q_2.

(c) Determine the magnitude of **E**.

Problem 2 A hollow, thin-walled insulating cylinder of radius R and length L (like the cardboard tube in a roll of toilet paper) has charge Q uniformly distributed over its surface.

(a) Calculate the electric potential at all points along the axis of the tube. Take the origin to be at the center of the tube, and take the potential to be zero at infinity.

(b) Use the result of part (a) to find the electric field at all points along the axis of the tube.

Problem 3 A cube has sides of length $L = 0.350\,\text{m}$. One corner is at the origin (Fig. 2). The nonuniform electric field is given by $\mathbf{E} = (-5.64\,\text{N C}^{-1}\,\text{m}^{-1})x\,\hat{\mathbf{i}} + (2.54\,\text{N C}^{-1}\,\text{m}^{-1})z\,\hat{\mathbf{k}}$.

(a) Find the electric flux through each of the six cube faces S_1, S_2, S_3, S_4, S_5, and S_6.

(b) Find the total electric charge inside the cube.

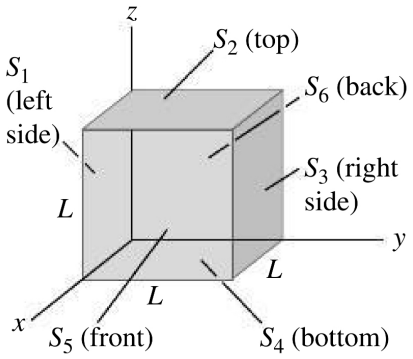

Figure 3

Problem 4 A spherical capacitor contains a charge of 3.10 nC when connected to a potential difference of 240 V. If its plates are separated by vacuum and the inner radius of the outer shell is 4.40 cm, calculate

(a) the capacitance,

(b) the radius of the inner sphere, and

(c) the electric field just outside the surface of the inner sphere.