COULOMB'S LAW – STEP BY STEP

1. Define an ORIGIN at a convenient point
2. Write the vector Rs from the ORIGIN to the SOURCE(s) (charge) location
   If you used an origin at the center of the grid (0,0,0):

   $$\overline{R}_s = x_s\,\hat{x} + y_s\,\hat{y} + z_s\,\hat{z}$$

3. Write the vector R_p from the ORIGIN to the location where you want to find the FIELD (field point).

   $$\overline{R}_p = x_p\,\hat{x} + y_p\,\hat{y} + z_p\,\hat{z}$$

4. Apply Coulomb's Law

   a. Write the vector from the SOURCE(s) to the FIELD
      $\overline{R}sp = \overline{R}p - \overline{R}s$
   b. Define the SOURCE (charge) distribution. (Note: This is a scalar.)

      $dq = \rho_l\,dl$ (Line charge)
      dl = dx, dy, or dz (See Table 3-1 of text)
      dl = dr, r dϕ, dz
      dl = dR, R dθ, Rsinθ dϕ
      $dq = \rho_s\,ds$ (Surface charge)
      ds = dx dy, dy dz, or dx dz
      ds = r dϕdz, drdz, r dr dϕ
      ds = R^2sinθ dθ dϕ, Rsinθ dR dϕ, R dR dθ
      $dq = \rho v\,dv$ (Volume charge)
      dv = dxdy dz
      dv = r dr dϕ dz
      dv = R^2sinθ dR dθ dϕ

   c. Write the electric field caused by the charge distribution.

      $$d\overline{E} = \frac{dq}{4\pi\varepsilon\left|\overline{R}_{sp}\right|^2}\hat{R}_{sp} = \frac{dq}{4\pi\varepsilon\left|\overline{R}_{sp}\right|^3}\overline{R}_{sp} \qquad \hat{R}_{sp} = \frac{\overline{R}_{sp}}{\left|\overline{R}_{sp}\right|}$$

      To find the magnitude of the vector: Take each vector component, square it, sum them, and take the square root.

      $|Rsp| = sqrt\ (R_x^2 + R_y^2 + R_z^2)$

   d. Sum or integrate the sources to find the field.

      $$\overline{E} = \int_{startsource}^{endsource} d\overline{E} = \int_{startsource}^{endsource} \frac{1}{4\pi\varepsilon\left|\overline{R}_{sp}\right|^3}\overline{R}_{sp}\,dq$$