

Electric Field

WHAT IS AN ELECTRIC FIELD?

An **electric field** is an alteration of space surrounding a charge. The electric field is defined by its effect in a test charge, q :

$$\vec{E} = \frac{\vec{F}_{on\ q}}{q}$$

The units for the electric field are N/C or V/m. The electric field exerts a force on a charge which is given by:

$$\vec{F} = q\vec{E}$$

MULTIPLE, SINGLE POINT CHARGES

In the case of a **single point charge**, the electric field generated is defined as:

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{q_i}{r^2} \hat{r}$$

In the case of a **multiple point charges**, the electric field generated is defined as:

$$\vec{E}_{net} = \sum_i \frac{1}{4\pi\epsilon_0} \frac{q_i}{r_i^2} \hat{r}_i$$

where \hat{r}_i is the unit vector of the *position*.

The **charge densities** for extended charged objects are defined in three ways depending on the shape of the charge density:

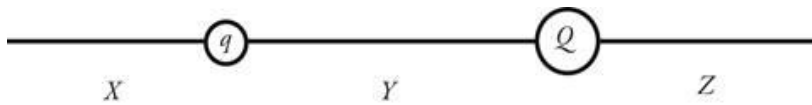
Linear charge density (C/m) $\lambda = Q/L$

Surface charge density (C/m²) $\eta = Q/A$

Volume charge density (C/m^3) $\rho = Q/V$

SAMPLE PROBLEMS

- 1) What is the electric field due to a point charge of $20\mu\text{C}$ at a distance 1m away from it? [$1.8 \times 10^5 \text{ N/C}$]
- 2) In the vicinity of a point charge, q , a $0.2 \mu\text{C}$ charge was placed so that a force of $5 \times 10^{-5} \text{ N}$ is applied to it due to the charge. Find the electric field produced by this unknown charge. [250 N/C]
- 3) The figure shows two unequal point charges, q and Q , of the same sign. Charge Q has greater magnitude than charge q . In which of the regions will there be a point at which the net electric field due to these two charges is zero?



- 4) The electric field strength in the space between two closely spaced parallel disks is $1.0 \times 10^5 \text{ N/C}$. This field is the result of transferring 3.9×10^9 electrons from one disk to the other. What is the diameter of the disks? [3.00 cm]