Electric Field Intensity
Lesson Notes

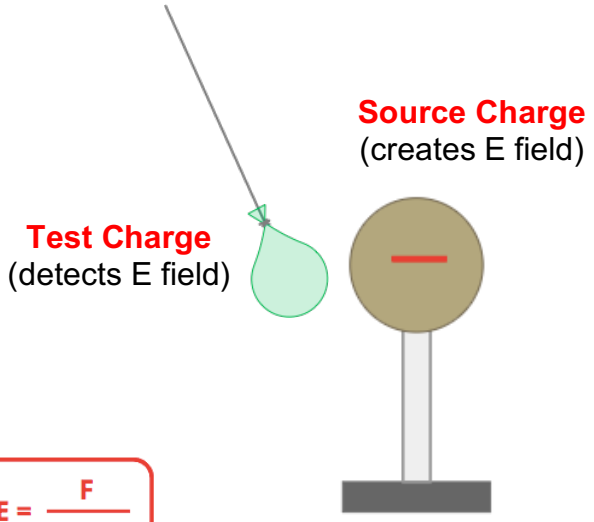
Focus Questions:

- What are the mathematical equations associated with the electric field intensity?
- How do you determine the direction of the electric field vector?

Electric Field as Force per Charge

A charged object creates an electric field; we refer to it as the ***source charge***.

To detect the presence of an electric field, a detector is required. We call the detector the ***test charge***.



The strength of the electric field (**E**) at any given location is the amount of force per charge on the test charge.

$$\text{Electric Field} = \frac{\text{Force on Test Charge}}{\text{Charge on Test Charge}} \qquad E = \frac{F}{q_{test}}$$

Unit on Electric Field: Newton/Coulomb, abbreviated N/C.

Electric Field Does not Depend upon q_{test}

- Just because **E** is calculated as F/q_{test}, the value of electric field strength (**E**) does not depend on the quantity of charge on the test charge.
- Doubling q_{test} doubles the force; but the ratio of F/q_{test} remains the same.
- Tripling q_{test} triples the force; but the ratio of F/q_{test} remains the same.

Derivation of a Second Electric Field Equation

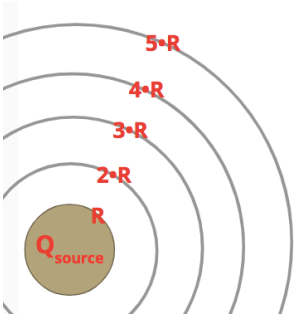
$$E = \frac{F}{q_{test}} \qquad \text{where ...} \quad F_{elect} = k \bullet \frac{Q_{source} \bullet q_{test}}{d^2}$$

$$E = \frac{k \bullet Q_{source} \bullet q_{test} / d^2}{q_{test}} \qquad E = \frac{k \bullet Q_{source}}{d^2}$$

$$k = 9.0 \times 10^9 \ N \bullet m^2/C^2$$

Inverse Square Law

There is an inverse square relationship between the electric field strength (**E**) and the distance of separation (**d**) from the source charge.



	Distance	E (N/C)
1	R	800 000
2	2•R	200 000
3	3•R	89 000
4	4•R	50 000
5	5•R	32 000

Doubling the distance from the source's center causes the E value to decrease by a factor of 4. Tripling the distance from the source's center causes the E value to decrease by a factor of 9. Etc.

Two Equations for Electric Field

Equation expressing **E** in terms of how it is measured.

$$E = \frac{F}{q_{test}}$$

Equation expressing **E** in terms of the variables that affect it.

$$E = \frac{k \bullet Q_{source}}{d^2}$$

Direction of Electric Field Vector

Electric field is a vector quantity and has a direction associated with it.

By definition, the direction of the electric field at any given location is the direction that a **+ test charge** would be pushed or pulled when placed at that location.

By logical extension, the electric field vector is directed ...

- towards negative source charges, and
- away from positive source charges.