Electric Fields and Forces

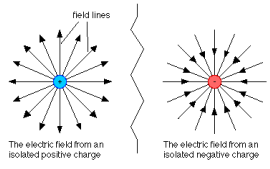
AP Physics B

Electric Fields

By definition, the are "LINES OF FORCE"

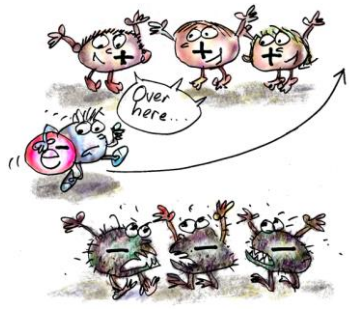
Some important facts:

- An electric field is a vector
- Always is in the direction that a POSITIVE "test" charge would move
- The amount of force PER "test" charge



If you placed a 2nd positive charge (test charge), near the positive charge shown above, it would move AWAY.

If you placed that same charge near the negative charge shown above it would move TOWARDS.



Electric Fields and Newton's Laws

$$F_g = G\frac{mM}{r^2}, F_e = k\frac{qQ}{r^2}$$

$$\frac{F_g}{m} = g, \quad \frac{F_e}{q} = E$$

Once again, the equation for ELECTRIC FIELD is symbolic of the equation for WEIGHT just like coulomb's law is symbolic of Newton's Law of Gravitation.

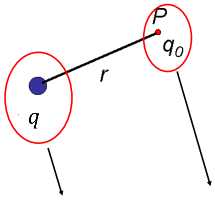
The symbol for Electric Field is, "E". And since it is defined as a force per unit charge he unit is Newtons per Coulomb, N/C.

NOTE: the equations above will ONLY help you determine the MAGNITUDE of the field or force. Conceptual understanding will help you determine the direction.

The "q" in the equation is that of a "test charge".

An Electric Point Charge

As we have discussed, all charges exert forces on other charges due to a field around them. Suppose we want to know how strong the field is at a specific point in space near this charge the calculate the effects this charge will have on other charges should they be placed at that point.



POINT CHARGE

TEST CHARGE

$$F_E = k\frac{qq_0}{r^2} \quad E = \frac{F_E}{q_0} \rightarrow F_E = Eq_0$$

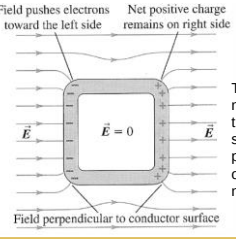
$$Eq_0 = k\frac{qq_0}{r^2}$$

$$E_{\text{pointcharge}} = \frac{kq}{r^2}$$

Electric Field of a Conductor

A few more things about electric fields, suppose you bring a conductor NEAR a charged object. The side closest to which ever charge will be INDUCED the opposite charge. However, the charge will ONLY exist on the surface. There will never be an electric field inside a conductor. Insulators, however, can store the charge inside.

There must be a positive charge on this side



There must be a negative charge on this side OR this side was induced positive due to the other side being negative.

Example #1

When a 5 nC test charge is placed at a point, it experiences a force of 2 x 10^{-4} N in the *x*-direction.

- What is the electric field $\vec{E}$ at that point?
- What is the force on an electron placed at this point?

Example #2

An electron is projected into a uniform electric field with a strength of E = 2000 N/C with an initial velocity of $v_0 = 10^6$ m/sec perpendicular to the field. By how much is the electron deflected after it has traveled 1 cm?

Example #3

The Earth has an electric field of about 150N/C pointed downward. A 1.00 μm radius water droplet is suspended in calm air. Find:

- the mass of the water droplet
- the charge on the water droplet
- the number of excess electrons on the droplet

Homework Assignment #2

- Pg. 574-575, (#31, 39, 43, 51)