Electric Field Theory

Lesson 4

Objectives

- define vector fields.
- compare forces and fields.
- explain, quantitatively, electric fields in terms of intensity (strength) and direction, relative to the source of the field and to the effect on an electric charge.

Write the parts in slimer green

Recall: The Gravitational Field

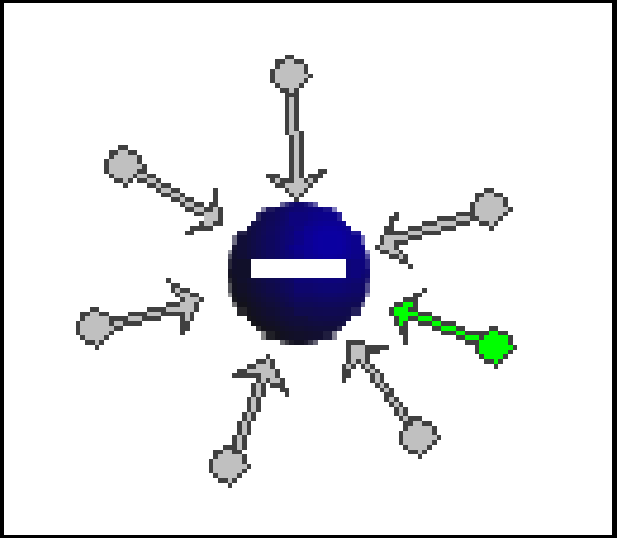
- An imaginary field which exists around all bodies in all directions.
- Shows the direction of the force of gravity.
- Only exists in theory, in practice, it does not really exist (although we can calculate the magnitude).
- Field lines are a vector quantity.

The Electric Field

- All electrically charged objects (can be positive or negative) create electric fields.
- The magnitude and direction of fields are represented by field lines. The greater the density of the lines, the greater the field.
- The direction of the electric field is the direction a positive test charge would move when placed in the field.

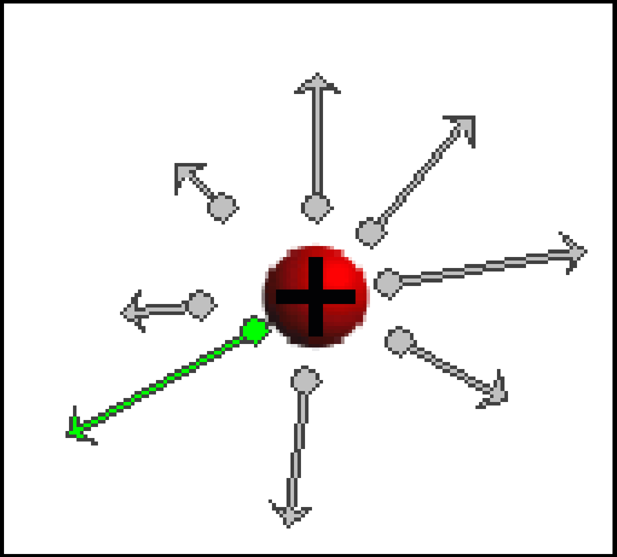
Direction of the Electric Field

- Field lines move towards negative charges.

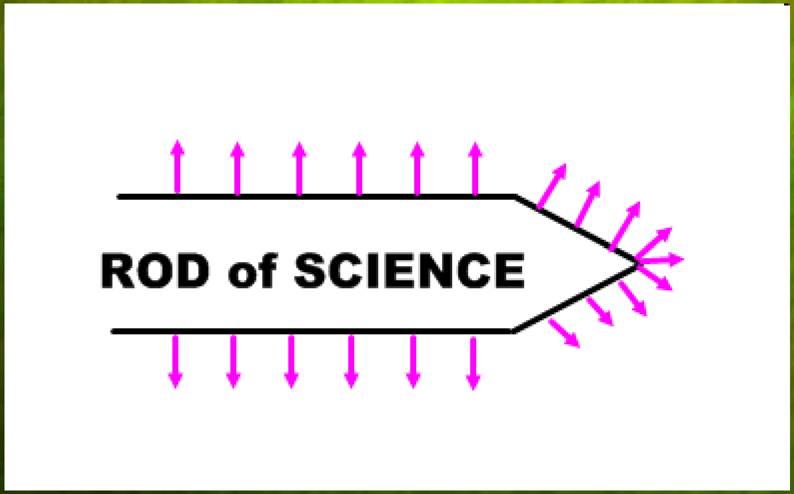


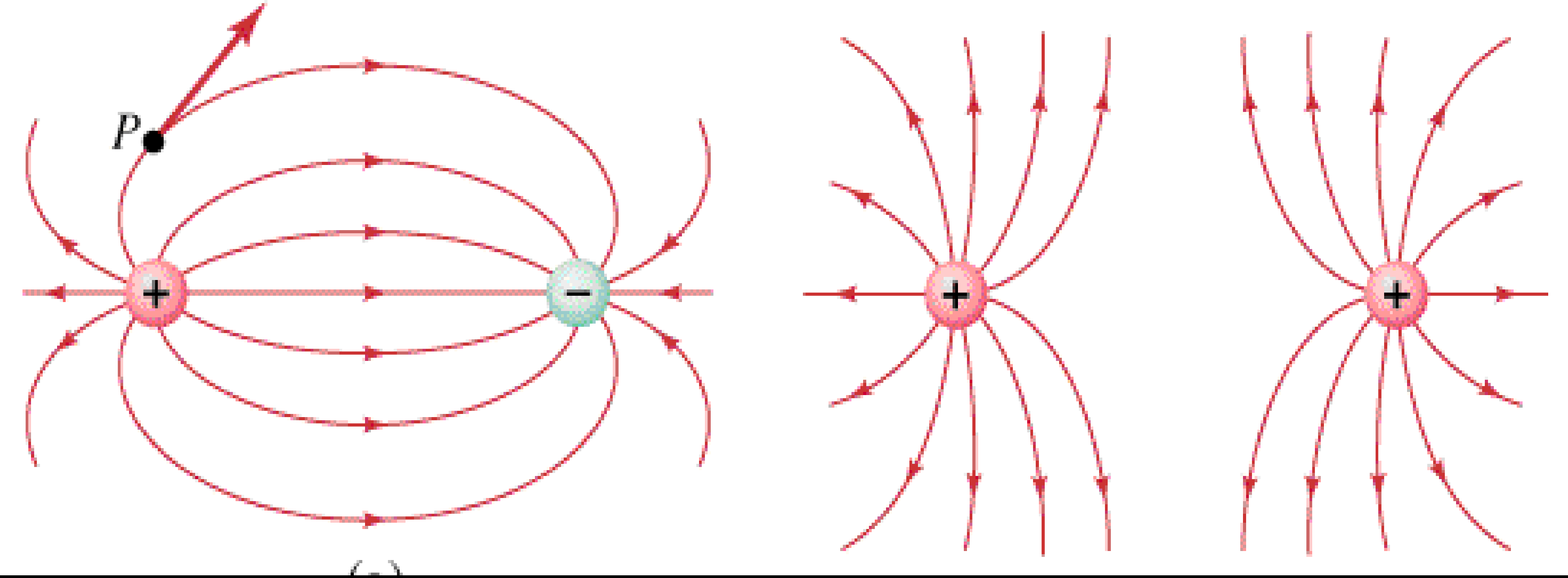
Remember: the field lines move in the same direction as a positive test charge would!

- Field lines move away from positive charges.



- The density (number of lines) indicates the relative magnitude of the field.
- Electric fields are greatest at points or sharp edges.





- Electric Fields Applet
- A Really Cool Electric Fields Applet
- 3-D nature of vectors

Field Strength

- Fields are vectors, they have magnitude and direction.
- Now that we know how to find the direction of the field, we need a way to find the magnitude.
- We have two formulas to calculate the field strength or field intensity at any point in space.

1st E-field Formula

$$|\vec{E}| = \frac{\vec{F}_e}{q}$$

Where:

E = absolute value of electric field strength

F_e = electric force acting on the test charge

q = magnitude of test charge

This is the definition of the electric field strength: the amount of electric force per unit of charge acting on a body.

Look familiar?

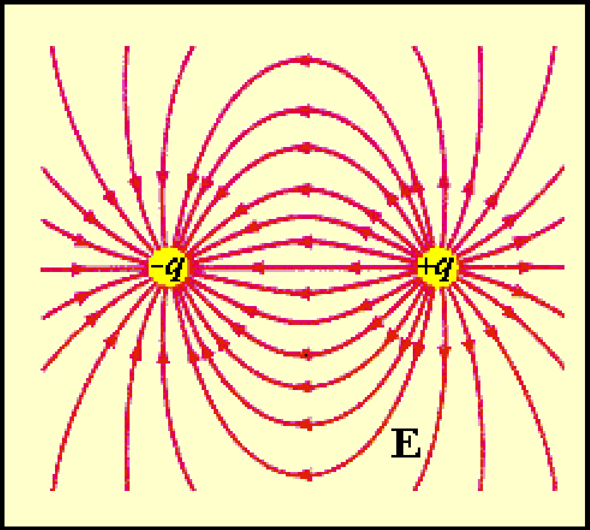
- This equation looks pretty similar to the equation for finding the gravitational field at any point…

$$\vec{E} = \frac{\vec{F}_e}{q} \qquad \vec{g} = \frac{\vec{F}_g}{m}$$

All of physics is related in one way to another! Another example of the appeal of GUTs!

Unit of Electric Fields

- The unit of the electric field is newtons per coulomb (N/C), another reminder of the first-principles definition of the term: the amount of electric force (N) per unit of charge (C).



Inverse Square Law

- Notice from the applet that the magnitude of the E field is stronger when closer to the charge, weaker when farther away.
- Electric fields obey the inverse square law.
- We can manipulate the general equation for the electric force to gain a second equation for determining electric field.

Second Electric Field Equation

Take $\vec{F}_e = \dfrac{kq_1q_2}{r^2}$ and divide by q on both sides.

$$\left|\vec{E}\right| = \frac{kq}{r^2}$$

where: $\vec{E}$ = magnitude of the electric field.

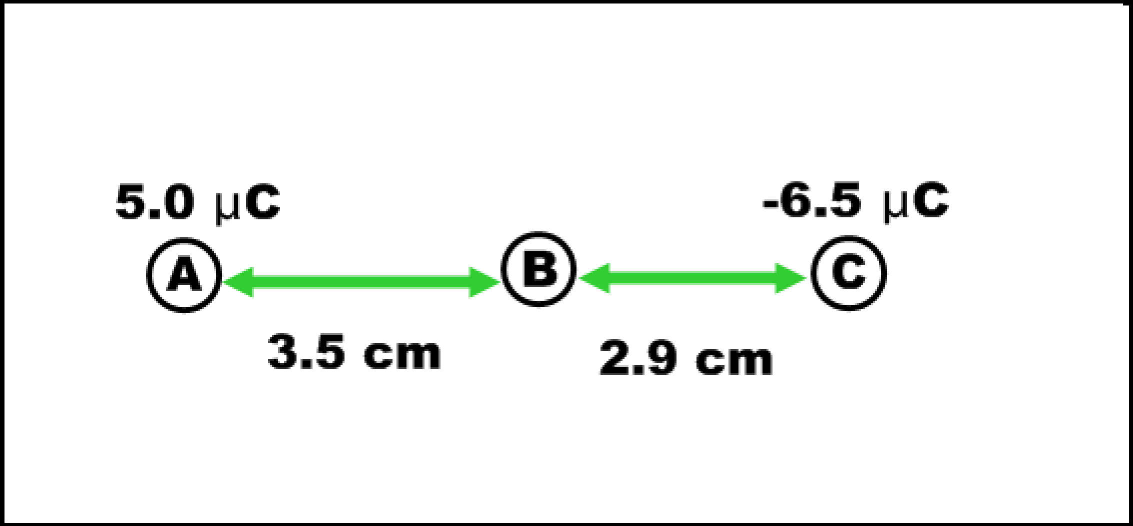
k = coulomb's constant

q = magnitude of the charge on the charge producing object.

Examples

- A positive test charge ($q = 4.0\ \mu C$) is placed in an electric field. The force on the charge is 0.60 N left. What is the magnitude and direction of the E-field at the location of the test charge?

- Find the electric field at point B.



- What is the electric field at a point half-way in between a charge of -3.50 μC and a charge of 3.00 μC if the charges are 44 cm apart?