Edgenuity

Warm-Up | Electric Fields

Lesson Question

How does an electric field affect the movement of a charge?

Lesson Goals

Describe the electric field due to a charge.

Analyze and interpret electric field lines.

Solve problems involving the electric field, charge, and force on an object.

Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

dipole	a pair of opposite electric charges of equal magnitude
electric field	the area around a charged object that can exert a force on other charged objects
field line	a line drawn on a diagram of charged particles indicating the direction of the flow of the field
point charge	a theoretical charge small enough to test the force exerted by a charged particle without moving the particle

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Coulomb's Law

- Coulomb's law states that the force of attraction between two charges is affected by the amount of [charge] and the distance between the two charges.
  - The unit of measure is newtons (N).
  - Coulomb's constant (k) is $8.99 \times 10^{9} \text{N} \cdot \frac{\text{m}^2}{\text{C}^2}$.
  - It obeys the inverse-square relationship with [distance].

$$F_e = \text{k}\frac{q_1 q_2}{d^2}$$

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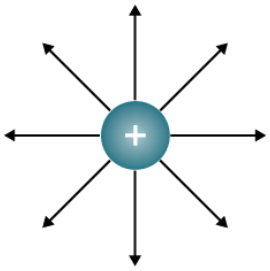
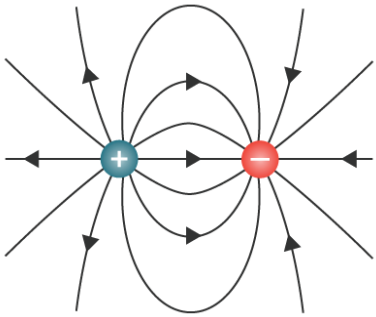
Charges



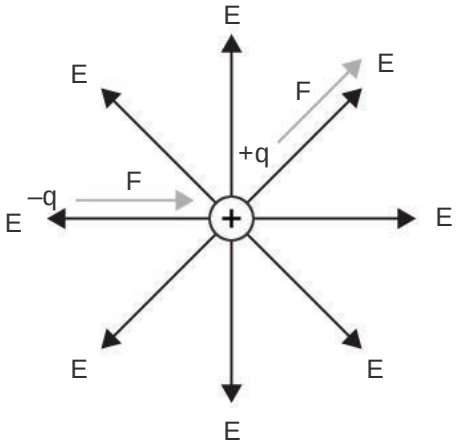


A point charge is a theoretical charge small enough to test the force exerted by a charged particle without moving the particle.

A dipole is a pair of opposite electric charges of equal magnitude.

Electric Field

- The **electric field** is the area around a charged object that can exert a force on other charged objects.
- Electric fields are represented by the force exerted on a positive point charge.
  - A positive charge placed in an electric field experiences a force (moves) in the same direction as the field.



  - A negative charge placed in an electric field experiences a force (moves) in the opposite direction as the field.

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Electric Force Formula

- The electric field formula comes from the electric force formula, $F_e = qE$.

$$E = \frac{F_e}{q}$$

  - E has a [direct] relationship with F_e.
  - F_e obeys the [inverse-square] relationship with distance, so E also obeys the inverse-square relationship with distance.

- The unit of the electric field is newtons per coulomb $\left(\frac{\text{N}}{\text{C}}\right)$.

Calculating Electric Field Using Coulomb's Law

STRATEGY

$$E = \frac{F_e}{q}$$

$$F_e = \text{k}\frac{q_1 q_2}{d^2}$$

$$E = \text{k}\left[\frac{q_1 q_2}{q d^2}\right] = \text{k}\frac{q}{d^2}$$

$$E = \text{k}\frac{q}{d^2}$$

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Calculating the Distance Using the Electric Field

EXAMPLE

At the position of a proton, the electric field generated by an electron orbiting the nucleus of a hydrogen atom is $5 \times 10^{11} \frac{\text{N}}{\text{C}}$. What is the radius of the electron's orbit?

- Given:
  - $q = 1.602 \times 10^{-19}\text{C}$
  - $E = 5 \times 10^{11} \frac{\text{N}}{\text{C}}$
- Unknown: *d*
- Formula to use: $E = \text{k}\frac{q}{d^2}$

$$\sqrt{d^2} = \sqrt{k\frac{q}{E}}$$

$$d = \sqrt{k\frac{q}{E}}$$

$$d = \sqrt{\left(8.99 \times 10^9 \ \text{N} \cdot \frac{\text{m}^2}{\text{C}^2}\right) \frac{(1.602 \times 10^{-19}\ \text{C})}{\left(5 \times 10^{11} \frac{\text{N}}{\text{C}}\right)}}$$

$$d = \sqrt{2.88 \times 10^{-21}\ \text{m}^2}$$

$$d = \boxed{5.4 \times 10^{-11}\ \text{m}}$$

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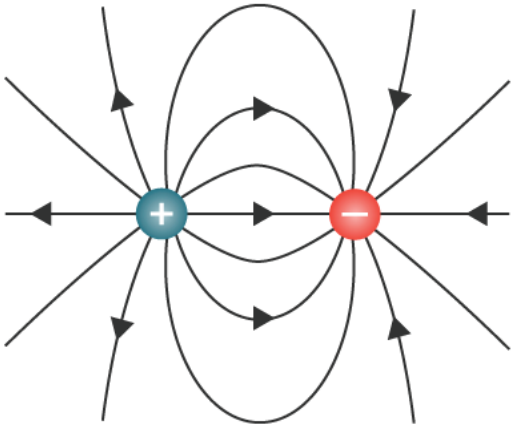
Understanding Electric Field Lines

- Electric **field lines** are lines drawn on a diagram of charged particles indicating the [strength] and direction of the flow of the field.
- Electric field lines:
  - point [away] from a positive charge and toward a negative charge.
  - do not cross each other.
  - indicate the strength of the electric field by how [close] together they are.



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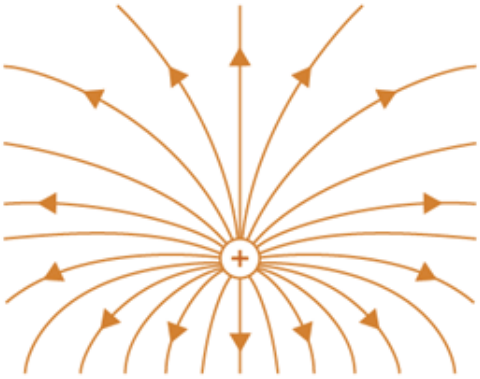
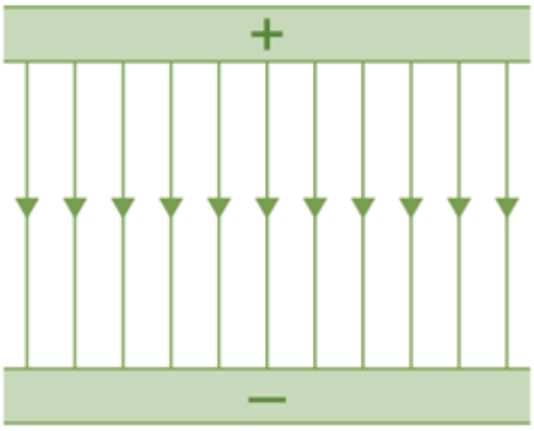
Formation of Field Lines

Field shape: Non-uniform



When it's non-uniform, the field is going to be strongest closest to the positive charge where the density of the field lines is the highest. And then it's going to be less strong as you go farther out.

Field shape: Uniform



The spacing between the electric field lines is consistent. And the density of the electric field lines is also consistent on both sides.

Summary | Electric Fields

Lesson Question

How does an electric field affect the movement of a charge?

Answer

(Sample answer) The electric field has a direct relationship with force. When the strength of the electric field (E) goes up, the force of the electric field (F_e) goes up. Positive charges move in the same direction as the electric field, and negative charges move in the opposite direction of the electric field.

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Review: Key Concepts

- Point charges can be used to find the [electric] field at a distance from a charged particle.
- $F_e = qE$
- $E = \mathrm{k}\frac{q}{d^2}$
- Electric field lines are lines drawn on a diagram of charged particles indicating the strength and [direction] of the flow of the field.
- Electric field lines:
  - point away from a [positive] charge and toward a negative charge.
  - do not cross each other.
  - use [density] of the field lines to indicate the strength of the electric field.

Summary | Electric Fields

Use this space to write any questions or thoughts about this lesson.