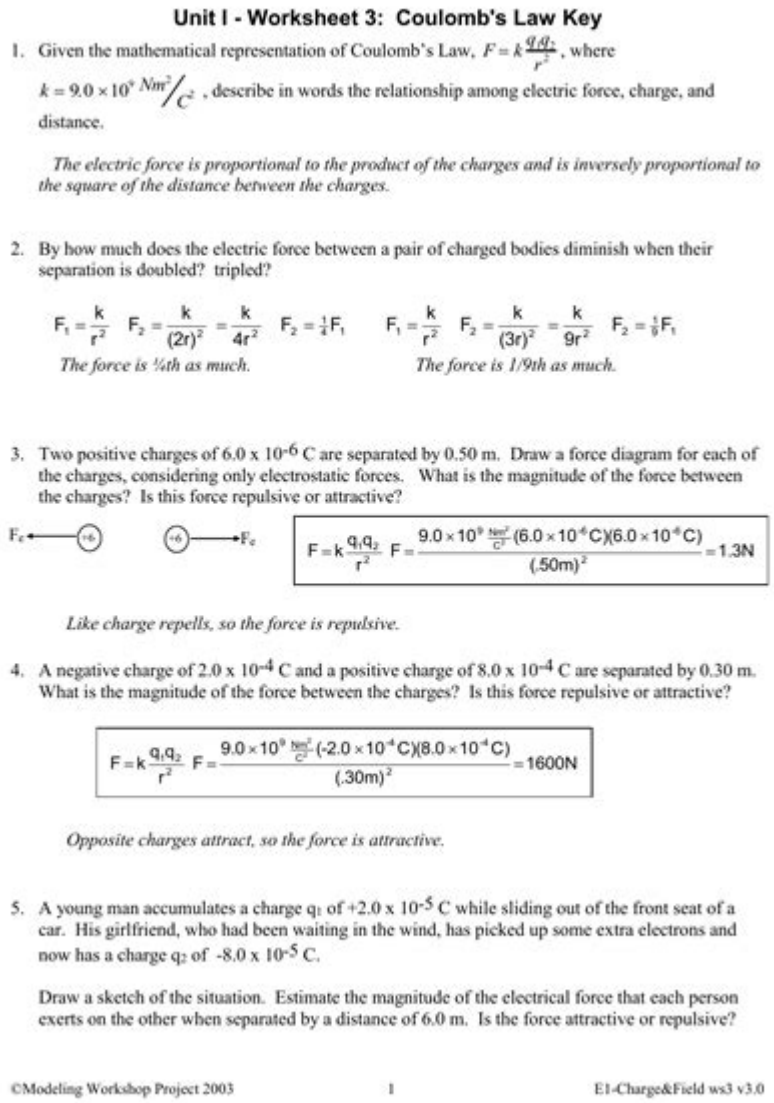
Coulombs Law Worksheet Answers



Unit I - Worksheet 3: Coulomb's Law Key

1. Given the mathematical representation of Coulomb's Law, $F = k\frac{q_1 q_2}{r^2}$, where $k = 9.0 \times 10^9 \, Nm^2/C^2$, describe in words the relationship among electric force, charge, and distance.

   The electric force is proportional to the product of the charges and is inversely proportional to the square of the distance between the charges.

2. By how much does the electric force between a pair of charged bodies diminish when their separation is doubled? tripled?

   $F_1 = \frac{k}{r^2}$ $F_2 = \frac{k}{(2r)^2} = \frac{k}{4r^2}$ $F_2 = \frac{1}{4}F_1$ — *The force is ¼th as much.*

   $F_1 = \frac{k}{r^2}$ $F_2 = \frac{k}{(3r)^2} = \frac{k}{9r^2}$ $F_2 = \frac{1}{9}F_1$ — *The force is 1/9th as much.*

3. Two positive charges of 6.0 x 10^{-6} C are separated by 0.50 m. Draw a force diagram for each of the charges, considering only electrostatic forces. What is the magnitude of the force between the charges? Is this force repulsive or attractive?

   $F_e \leftarrow (+6)$ $(+6) \rightarrow F_e$

   $F = k\frac{q_1 q_2}{r^2}$ $F = \frac{9.0\times10^9 \frac{Nm^2}{C^2}(6.0\times10^{-6}C)(6.0\times10^{-6}C)}{(.50m)^2} = 1.3N$

   Like charge repells, so the force is repulsive.

4. A negative charge of 2.0 x 10^{-4} C and a positive charge of 8.0 x 10^{-4} C are separated by 0.30 m. What is the magnitude of the force between the charges? Is this force repulsive or attractive?

   $F = k\frac{q_1 q_2}{r^2}$ $F = \frac{9.0\times10^9 \frac{Nm^2}{C^2}(-2.0\times10^{-4}C)(8.0\times10^{-4}C)}{(.30m)^2} = 1600N$

   Opposite charges attract, so the force is attractive.

5. A young man accumulates a charge q_1 of +2.0 x 10^{-5} C while sliding out of the front seat of a car. His girlfriend, who had been waiting in the wind, has picked up some extra electrons and now has a charge q_2 of -8.0 x 10^{-5} C.

   Draw a sketch of the situation. Estimate the magnitude of the electrical force that each person exerts on the other when separated by a distance of 6.0 m. Is the force attractive or repulsive?

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Coulombs law worksheet answers are essential for students and educators alike, as they provide clarity and understanding of the principles governing electrostatic forces between charged particles. Coulomb's Law is foundational in the field of electrostatics, which deals with electric charges at rest. In this article, we will explore the nuances of Coulomb's Law, how to solve related problems, and provide an overview of common worksheet problems and their answers.

Understanding Coulomb's Law

Coulomb's Law describes the force between two charged objects. Mathematically, it is expressed as:

$$ F = k \frac{|q_1 \cdot q_2|}{r^2} $$

Where:
- F is the magnitude of the force between the charges,
- k is Coulomb's constant ($8.99 \times 10^9 \, \text{N m}^2/\text{C}^2$),
- q_1 and q_2 are the amounts of the charges,
- r is the distance between the centers of the two charges.

This law indicates that the force is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between them.

Key Concepts of Coulomb's Law

Understanding the key concepts of Coulomb's Law is critical for solving problems related to it. Here are a few important points:

- **Electric Charge:** Charges can be positive or negative, and like charges repel while opposite charges attract.
- **Distance:** The force decreases rapidly as the distance between charges increases, following an inverse square relationship.
- **Coulomb's Constant:** This constant varies in different mediums; the value given above is for a vacuum.
- **Vector Nature of Forces:** The direction of the force depends on the nature of the charges involved.

Common Types of Problems on Coulomb's Law Worksheets

Coulomb's Law worksheets typically include various problem types that test students' understanding and application of the law. Here are some common problem types:

1. Calculating the Force Between Two Charges

These problems require students to apply the formula directly to compute the force. For example:

Problem: Calculate the force between two charges of $3 \, \mu C$ and $-4 \, \mu C$ separated by a distance of $0.5 \, m$.

Solution Steps:
1. Convert microcoulombs to coulombs:
- $q_1 = 3 \, \mu C = 3 \times 10^{-6} \, C$
- $q_2 = -4 \, \mu C = -4 \times 10^{-6} \, C$
2. Substitute the values into Coulomb's Law:
$$ F = 8.99 \times 10^9 \frac{|3 \times 10^{-6} \cdot -4 \times 10^{-6}|}{(0.5)^2} $$
3. Calculate the force.

2. Determining Charge from Force and Distance

In these problems, students are given the force and distance and must find the charge.

Example Problem: If two charges are separated by $1 \, m$ and experience a force of $0.02 \, N$, what are the charges if they are equal?

Solution Steps:
1. Rearranging Coulomb's Law to solve for q:
$$ F = k \frac{q^2}{r^2} \implies q = \sqrt{\frac{F \cdot r^2}{k}} $$
2. Substitute $F = 0.02 \, N$, $r = 1 \, m$, and $k = 8.99 \times 10^9$:
$$ q = \sqrt{\frac{0.02 \cdot (1)^2}{8.99 \times 10^9}} $$
3. Calculate the charge.

3. Understanding the Direction of Forces

Many worksheets include problems that ask students to determine the direction of the force vector between charges.

Example Problem: Two charges $+5 \, C$ and $-3 \, C$ are placed $2 \, m$ apart. What is the direction of the force on each charge?

Solution Steps:
1. The force on the $+5 \, C$ charge due to the $-3 \, C$ charge is attractive.
2. Conversely, the force on the $-3 \, C$ charge due to the $+5 \, C$ charge is also attractive.
3. Hence, both forces point toward each other.

Practice Problems and Answers

To help students prepare, here is a set of practice problems along with their answers:

Practice Problems

1. Calculate the force between two charges, $2 \, \mu C$ and $5 \, \mu C$, separated by $0.1 \, m$.

2. Two charges, $6 \, C$ and $-2 \, C$, are $3 \, m$ apart. Find the force acting between them.

3. If the force between two charges is $0.1 \, N$ and the distance is $0.4 \, m$, what is the product of the charges?

Answers

1. Using Coulomb's Law:
   $$ F = k \frac{|2 \times 10^{-6} \cdot 5 \times 10^{-6}|}{(0.1)^2} = 0.099 \, N $$

2.
   $$ F = k \frac{|6 \cdot (-2)|}{(3)^2} = 0.4 \, N $$

3. Rearranging gives:
   $$ q_1 \cdot q_2 = \frac{F \cdot r^2}{k} \implies q_1 \cdot q_2 = \frac{0.1 \cdot (0.4)^2}{8.99 \times 10^9} \approx 1.78 \times 10^{-12} $$

Conclusion

Coulombs law worksheet answers not only provide solutions but also reinforce the understanding of electrostatic principles. Practicing a variety of problems enhances problem-solving skills and prepares students for advanced topics in physics. By mastering Coulomb's Law, students can build a strong foundation for future studies in electrostatics and electromagnetism.

Frequently Asked Questions

What is Coulomb's Law and how is it expressed mathematically?

Coulomb's Law describes the electrostatic force between two charged objects. It is expressed mathematically as F = k |q1 q2| / r^2, where F is the force between the charges, k is Coulomb's constant, q1 and q2 are the magnitudes of the charges, and r is the distance between the centers of the two charges.

How do you calculate the force between two charges using a Coulomb's law worksheet?

To calculate the force between two charges using a worksheet, identify the values of the charges (q1 and q2) and the distance (r) between them, then apply the formula F = k |q1 q2| / r^2, substituting in the known values.

What are the units used in Coulomb's Law calculations?

The units used in Coulomb's Law calculations include Coulombs (C) for charge, meters (m) for distance, and Newtons (N) for force.

What is the significance of the sign in Coulomb's Law?

The sign of the electrostatic force indicates the nature of the interaction: if the product of the charges (q1 q2) is positive, the force is repulsive; if it is negative, the force is attractive.

How can you use a Coulomb's law worksheet to solve problems involving multiple charges?

To solve problems involving multiple charges, use the principle of superposition: calculate the force between each pair of charges separately and then vectorially add the forces to find the net force on a particular charge.

What common mistakes should be avoided when completing a Coulomb's law worksheet?

Common mistakes include forgetting to convert units to the SI system, miscalculating distances between charges, and not considering the direction of the forces when adding them vectorially.

Can Coulomb's Law be applied to charges in different

mediums?

Yes, Coulomb's Law can be applied to charges in different mediums, but the value of Coulomb's constant (k) will change based on the medium's permittivity. This affects the electrostatic force calculated.

Where can you find practice worksheets for Coulomb's Law?

Practice worksheets for Coulomb's Law can typically be found on educational websites, physics textbooks, or online resource platforms that offer physics exercises and worksheets.

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