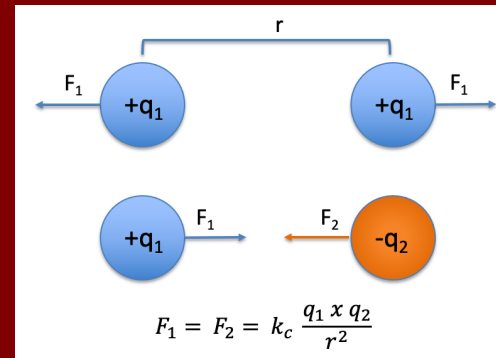
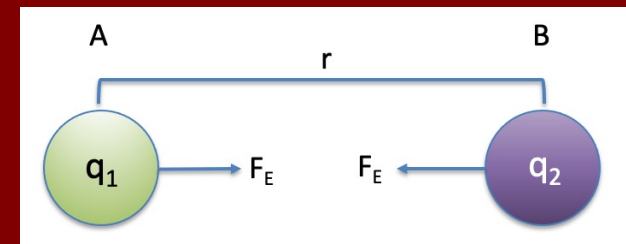


Electric Force and Coulomb's Law

- Electric Force
- Coulombs
- Electric Force vs. Gravitation Force
- Newton's 3rd Law
- Calculating Net Force
- Practice



$$F_E = \frac{kq_1q_2}{r^2}$$



Preview File

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Electric Force Overview

$$F_E = \frac{kq_1q_2}{r^2}$$

What if you halved the distance (r)?

$$F_E = \frac{kq_1q_2}{r^2} \quad \longrightarrow \quad F_E = \frac{kq_1q_2}{\left(\frac{1}{2}r\right)^2}$$

$$F_E = \frac{kq_1q_2}{\frac{1}{4}} \quad \longrightarrow \quad 4F_E = kq_1q_2$$

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Charles Augustin de Coulomb



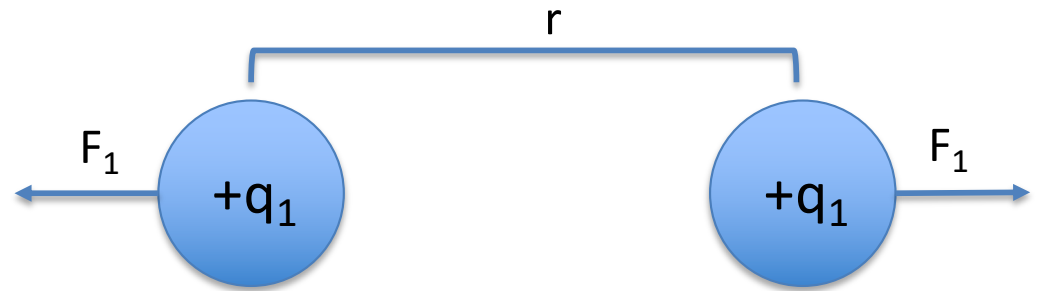
- 1736-1806
- Developed the force relationship between electric charges in the 1780's (now known as Coulomb's Law)
- Showed that the electric force between two objects follows the inverse square law

What is a Coulomb?

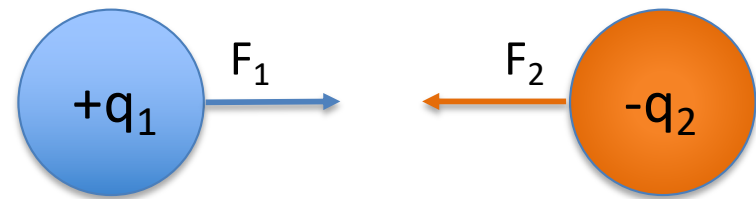
- A coulomb (C) is approximately the amount of electric charge that passes through a standard 60-W light bulb in 2 s
- _____
- An electrostatic shock that you might receive from touching a metallic doorknob would be much less than a microcoulomb (10^{-6} C)
- A lightning bolt may transfer up to 20 C



Coulomb's Law Mathematically



$$F_E = \frac{kq_1q_2}{r^2}$$



$$F_1 = F_2 = k_c \frac{q_1 \times q_2}{r^2}$$

Where

- q_1 and q_2 are the charges on each object in Coulombs (C)
- r is the separation distance in meters (m)
- k is the called Coulomb's constant ($9.0 \times 10^9 \text{ Nm}^2/\text{C}^2$)

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Check Your Understanding

What is the magnitude of the force of repulsion between two small spheres 1.0 m apart, if each has a charge of 1.0×10^{-12} C?

$$F_E = \frac{kq_1q_2}{r^2}$$

$$k = (9.0 \times 10^9 \text{ Nm}^2/\text{C}^2)$$

Electric Force (F_E) vs. Gravitational Force (F_g)

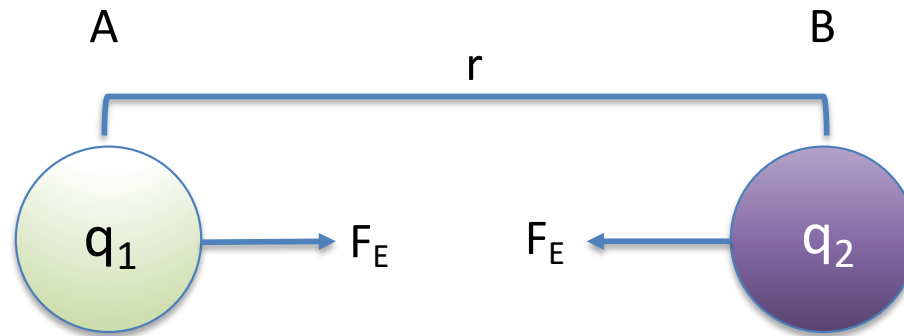
$$F_E = \frac{kq_1q_2}{r^2} \qquad F_g = \frac{Gm_1m_2}{r^2}$$

Similarities:

- Both are inverse square laws that are also proportional to the product of another quantity
 - for gravity, it is the product of two masses, and for the electric force, it is the product of the two charges
- Distance in both cases is measured from the centres of the spheres

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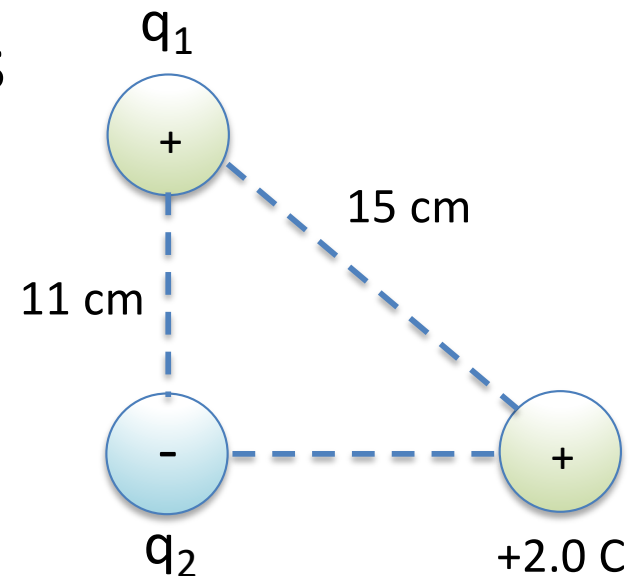
Newton's 3rd Law



Newton's Third Law – For every action there is an equal and opposite reaction. The electric force exerted on body A by body B is equal in magnitude and opposite in direction to the force exerted on B by A.

Calculating the Net Electric Force on an Object

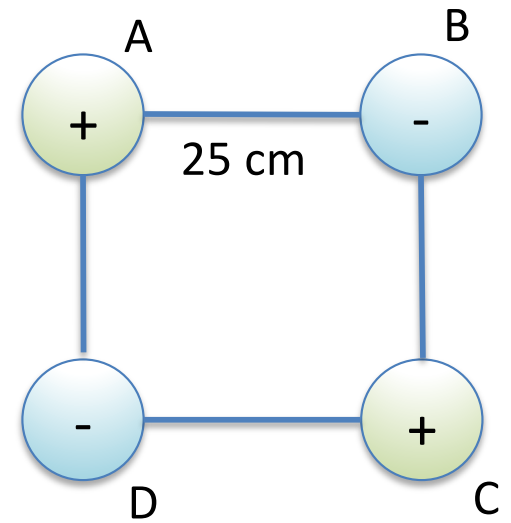
- The net force on a single charge is the vector sum of all independently calculated forces acting on it
- Only compare two objects at a time
- Just like before
 - 1) Find the x and y components
 - 2) Setup your triangle
 - 3) Solve for the hypotenuse
 - 4) Include the direction



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Check Your Understanding

Spheres A, B, C, and D, each with a charge of magnitude $5.0 \times 10^{-6} \text{ C}$, are situated at the corners of a square whose sides are 25 cm long. The charges of the objects are shown below. Calculate the net force acting on each of the four spheres.



$$k = (9.0 \times 10^9 \text{ Nm}^2/\text{C}^2)$$