Coulomb's Law

- _____ charges exert _____ on each other
  - Related to the _____ of the charges and the _____ between them
- If the signs are _____ force _____
- If the signs are _____ force _____

Coulomb's Law

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

Where F = electrostatic force, k = constant (8.99×10^9 Nm²/C²), q = charge, r = distance between the charges

In a hydrogen atom, the electron ($q = -1.60 \times 10^{-19}$ C) is 5.29×10^{-11} m away from the proton of equal charge magnitude. Find the electrical force of attraction.

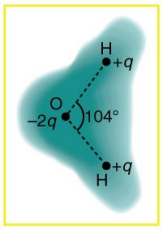
Force on 1 charge by 2 others

- Work in _____ parts
  - Find _____ of attraction by _____ of the points
  - Find _____ of attraction by the _____ point
  - Add the force _____
    - REMEMBER!!!!! You have to add the _____ and _____ _____!!!!!

There are three charges in a straight line: $q_1 = +2\ \mu C$ at x = −0.1 m, $q_2 = -3\ \mu C$ at x = 0 m, $q_3 = +5\ \mu C$ at x = 0.3 m. What is the force on q_2?

There are three charges: $q_1 = +2\ \mu C$ at (0, 0.3) m, $q_2 = -3\ \mu C$ at (0, 0) m, $q_3 = +5\ \mu C$ at (0.1, 0.2) m. What is the force on q_2?

Homework



1. The figure shows the charge distribution in a water molecule, which is called a polar molecule because it has an inherent separation of charge. Given water's polar character, explain what effect humidity has on removing excess charge from objects.
2. A proton and an electron are held in place on the *x* axis. The proton is at $x = -d$, while the electron is at $x = +d$. They are released simultaneously, and the only force that affects their motions is the electrostatic force of attraction that each applies to the other. Which particle reaches the origin first? Give your reasoning.
3. Identical point charges are fixed to opposite corners of a square. Where does a third point charge experience the greater net force, at one of the empty corners or at the center of the square? Account for your answer.
4. What is the repulsive force between two pith balls that are 8.00 cm apart and have equal charges of – 30.0 nC? (OpenStax 18.10) $\mathbf{1.27 \times 10^{-3} N}$
5. (a) How strong is the attractive force between a glass rod with a 0.700 μC charge and a silk cloth with a –0.600 μC charge, which are 12.0 cm apart, using the approximation that they act like point charges? (b) Discuss how the answer to this problem might be affected if the charges are distributed over some area and do not act like point charges. (OpenStax 18.11) **0.263 N**
6. Two point charges exert a 5.00 N force on each other. What will the force become if the distance between them is increased by a factor of three? (OpenStax 18.12) **0.556 N**
7. Two point charges are brought closer together, increasing the force between them by a factor of 25. By what factor was their separation decreased? (OpenStax 18.13) **5 times**
8. How far apart must two point charges of 75.0 nC (typical of static electricity) be to have a force of 1.00 N between them? (OpenStax 18.14) **7.12 mm**
9. If two equal charges each of 1 C each are separated in air by a distance of 1 km, what is the magnitude of the force acting between them? You will see that even at a distance as large as 1 km, the repulsive force is substantial because 1 C is a very significant amount of charge. (OpenStax 18.15) $\mathbf{9 \times 10^3}$ **N**
10. A test charge of +2 μC is placed halfway between a charge of +6 μC and another of +4 μC separated by 10 cm. (a) What is the magnitude of the force on the test charge? (b) What is the direction of this force (away from or toward the +6 μC charge)? (OpenStax 18.16) **10 N, away from the 6 μC charge**
11. Bare free charges do not remain stationary when close together. To illustrate this, calculate the acceleration of two isolated protons separated by 2.00 nm (a typical distance between gas atoms). (OpenStax 18.17) $\mathbf{3.45 \times 10^{16}\ m/s^2}$
12. (a) Find the ratio of the electrostatic to gravitational force between two electrons. (b) What is this ratio for two protons? (c) Why is the ratio different for electrons and protons? (OpenStax 18.21) $\mathbf{4.16 \times 10^{42}, 1.24 \times 10^{36}}$