Coulomb's Law

VANCOUVER COMMUNITY COLLEGE

COULOMB'S LAW

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

where F = the electrostatic force between the charges (N)

k = 9.0×10^9 $N \cdot m^2/C^2$

q_1, q_2 = the strengths of the charges (C)

r = the radius (distance) between the charges (m)

NOTES

[1] The charge on one electron (e) = -1.60×10^{-19} C (and therefore the charge on one proton is $+1.60 \times 10^{-19}$ C). Charge is sometimes expressed in terms of e rather than in coulombs.

[2] Like charges repel each other; unlike charges attract. For the purposes of Coulomb's Law, use the unsigned charges for q_1 and q_2 and decide from the charges whether the result is an attraction or a repulsion.

[3] For several charges present in one region, the net force on one of the charges is equal to the vector sum of the forces of each individual charge acting alone on the charge of interest.

[4] When an uncharged sphere is touched with an identically-sized sphere with charge q and then removed, each sphere will carry a charge equal to q ÷ 2.

EXERCISES

A. What effect would each of the following have on the electrostatic force between two charges?
   1) The distance between the charges is doubled.
   2) The distance between the charges is tripled.
   3) The distance between the charges is halved.
   4) One of the charges is doubled.
   5) Both charges are doubled.
   6) One charge is tripled while the other charge is halved.
   7) One charge is tripled, the other is halved, and the distance between the charges is halved.

B. What is the force of repulsion between two small charges 75.0 cm apart if each has a charge of 1.65×10^{-12} C?

C. What is the force between two electrons if they are placed 15.0 cm apart?

D. What is the distance between two protons when they repel each other with a force of 4.75×10^{-11} N?

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E. Two equal 1.15 µC charges repel each other with a force of 4.55×10^{-4} N. How far apart are they?

F. Two small spheres 15.0 cm apart attract each other with a force of 4.35×10^{-6} N. What would the force be if the following independent changes were made:
   1) Both charges are doubled, but the distance remains unchanged.

   2) The separation is increased to 45.0 cm.

   3) An uncharged, identical sphere is touched to one of the spheres, and then taken away.

G. The force of electrostatic repulsion between two small negatively-charged objects is 4.25×10^{-5} N when the distance between them is 24.0 cm. What is the force of repulsion when the distance is changed to:
   1) 12.0 cm   2) 48.0 cm   3) 4.0 cm

H. The force of repulsion between two identically-charged spheres placed 1.55 m apart is 9.75×10^{-15} N. Determine the charge on the spheres.

I. [*Phys 093*] Consider the following:

+5.0 µC   −3.0 µC   +7.0 µC

q_1 q_2 q_3

|←7.5 mm→|←9.5 mm→|
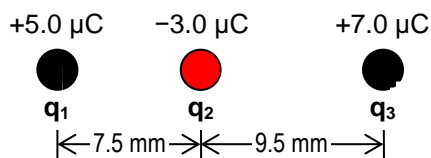
   1) What is the force on q_2 due to q_1?

   2) What is the force on q_2 due to q_3?

   3) What is the magnitude of the net force on q_2?

   4) In which direction is this force?

SOLUTIONS
A. (1) $\frac{1}{4}$F   (2) $\frac{1}{9}$F   (3) 4F   (4) 2F   (5) 4F   (6) $\frac{3}{2}$F   (7) 6F
B. 4.36×10^{-14} N   C. 1.02×10^{-26} N   D. 2.20×10^{-9} m   E. 5.11 m
F. (1) 1.74×10^{-5} N   (2) 4.83×10^{-7} N   (3) 2.18×10^{-8} N
G. (1) 1.70×10^{-4} N   (2) 1.06×10^{-5} N   (3) 1.53×10^{-3} N
H. 1.61×10^{-12} C   I. (1) 2.4×10^3 N left   (2) 2.1×10^3 N right   (3) 3×10^2 N   (4) left