PHYS 202

Ch. 1

Coulomb’s Low

Chapter 1

Chapter One

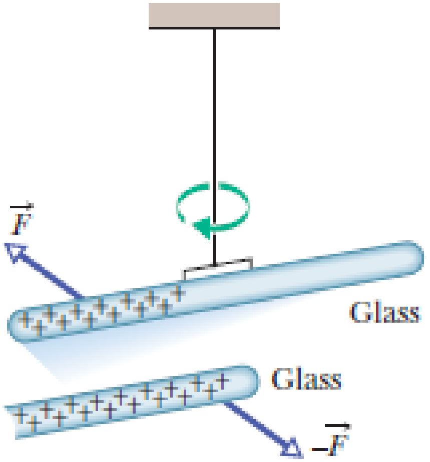
Coulomb's Low

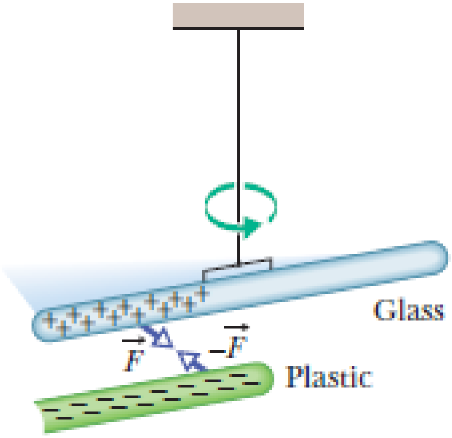
- ***Coulomb's Low***
- ***Charge is Quantized***
- ***Charge is Conserved***

Coulomb's Low

Electric Charge

Particles with the same sign of electrical charge repel each other, and particles with opposite signs attract each other.





Coulomb's Low

Conductors and Insulators

Materials are classified into four categories in terms of their capability of conducting electricity.

- Insulators: materials has electrons which are not free to move.
- Conductors: materials has electrons which are free to move.
- Semiconductors: materials intermediate between conductors and insulators.
- Superconductors: materials that almost all electrons are free to move, perfect conductors.

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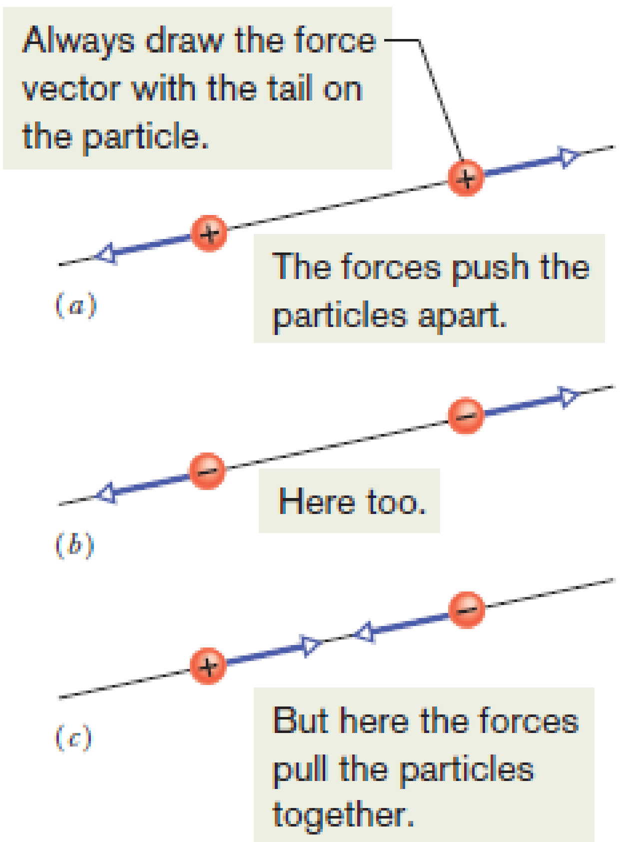
Coulomb's Law



- Need to know that the current i is given generally by:

$$i = \frac{dq}{dt}$$

- From this, the SI unit for charge is:

$$1\ \mathrm{C} = (1\ \mathrm{A})(1\ \mathrm{s})$$

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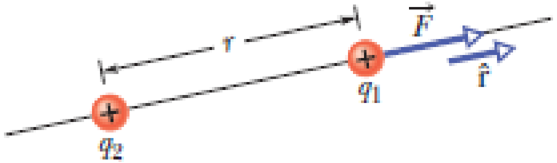
- The electrostatic force in Coulomb's law is given by:

$$F = \frac{1}{4\pi\varepsilon_0}\frac{|q_1||q_2|}{r^2}$$



$$k = \frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^9\,\mathrm{N \cdot m^2/C^2}.$$

where ε_0 is known as the permittivity and equals to

$$\varepsilon_0 = 8.85 \times 10^{-12}\,\mathrm{C^2/N \cdot m^2}.$$

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Example 1:

Two charges 4 μC and -3 μC are separated by 2 cm. The force between them is:

Solution:

(C)

(A) 200 N
(B) 240 N
(C) 270 N
(D) 300 N

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Example 2:

The distance between two point charges 2.4 μC and -1.8 μC for the electrostatic force to be of magnitude 10.8 N is:

Solution:

(A)

(A) 6 cm
(B) 8 cm
(C) 10 cm
(D) 12 cm

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Example 3:

A point charge 2.0 μC is placed at a distance 4 cm form another point charge q. If the attractive force between them is 56.25 N, then q is:

Solution:

(B)

(A) -2 μC
(B) -5 μC
(C) 2 μC
(D) 5 μC

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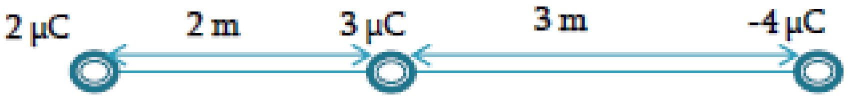
Example 4:

Three point charges 2.0, 3.0, and -4.0 μC are located as shown in the figure. The magnitude of the force acting on the 2 μC charge due to the others is:

Solution:

(D)

(A) 0.04608 N
(B) 0.03137 N
(C) 0.02404 N
(D) 0.01062 N



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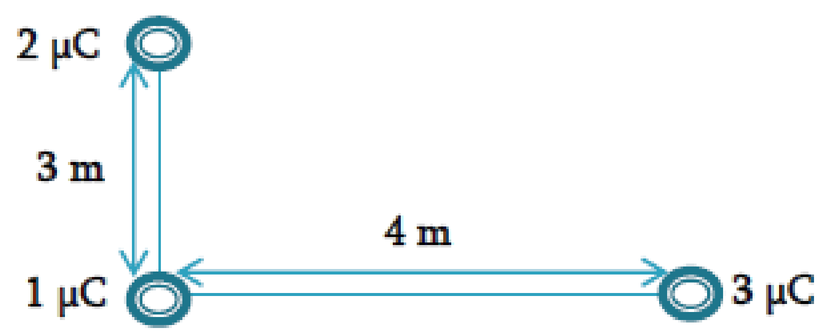
Example 5:

Three point charges 1.0, 2.0, and 3.0 μC are arranged as shown in the figure. The magnitude of the force acting on the 2 μC charge due to the others is:

Solution:

(C)

(A) 0.001654 N
(B) 0.002948 N
(C) 0.003950 N
(D) 0.004658 N



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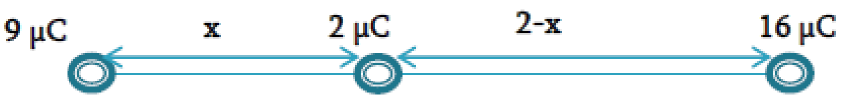
Example 6:

Two charges 9.0 and 16.0 μC are separated by a distance of 2 m. The distance from 9.0 μC charge where a third charge 2 μC can be placed for a zero net force on it should be:

Solution:

(B)

(A) 0.42 m
(B) 0.86 m
(C) 1.06 m
(D) 1.69 m



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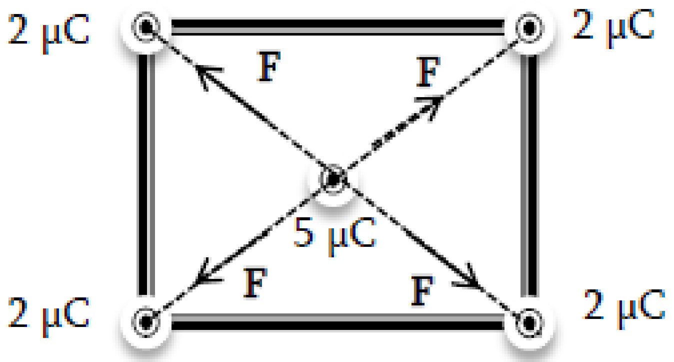
Example 5:

Four identical charges (2 μC) are located at the corners of a square of side 5 cm. The magnitude of the electric force on a 5 μC located at the center of the square is:

Solution:

(D)

(A) 0.015 N
(B) 0.024 N
(C) 0.095 N
(D) Zero



Charge is Quantized

Charge Is Quantized

$$q = ne,$$

$$n = \pm 1, \pm 2, \pm 3, \ldots,$$

$$e = 1.602 \times 10^{-19}\ \text{C}.$$

$$i = \frac{dq}{dt} = \frac{q}{t}$$

Charge is Quantized

Example 6:

The number of electrons would be removed from a metal to have a charge of 4.8 μC is:

Solution:

(C)

(A) 1×10^{13} electrons
(B) 2×10^{13} electrons
(C) 3×10^{13} electrons
(D) 4×10^{13} electrons

Charge is Quantized

Example 7:

A 5×10^{20} electrons pass between two points in 4 s, the current is:

Solution:

(C)

(A) 10 A
(B) 15 A
(C) 20 A
(D) 25 A

Charge is Conserved

Charge Is Conserved

Conservation of Charge

The net electric charge of any isolated system is always conserved.