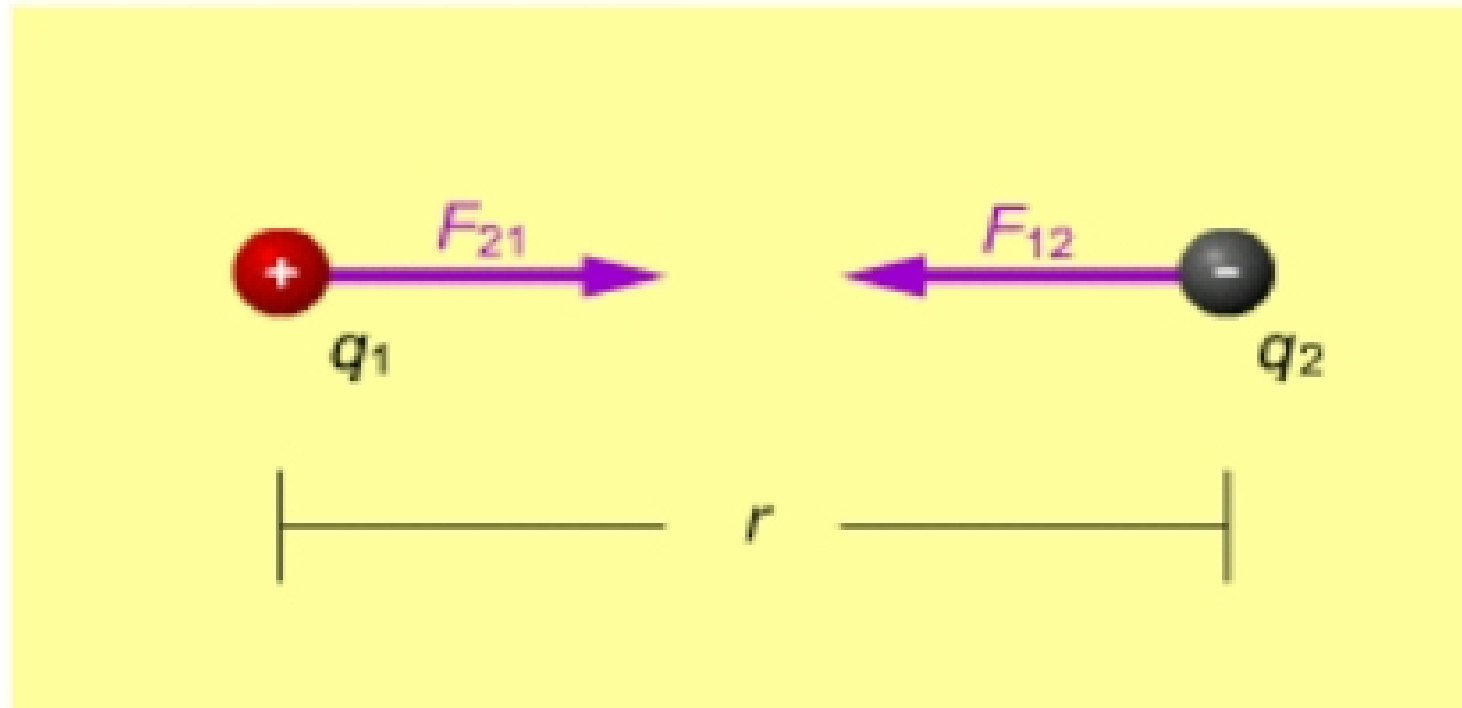


- Coulomb's Law of two point charges:



Force is a vector.

The direction of the Coulomb force follows

1. The line defined by the two point charges.
2. Like charges repel, unlike charges attract.

A reminder of
Newton's gravitational
force here.

Coulomb's law: The electrostatic force a charged particle exerts on another is proportional to the product of the charges and inversely proportional to the square of the distance between them.

- Coulomb's Law of two point charges:

Coulomb's law

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

F = force

k = Coulomb's constant

q = charge

r = distance between charges

Constant $k = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$



$$k = \frac{1}{4\pi\epsilon_0}$$

Coulomb's law, permittivity constant

$$F = \frac{1}{4\pi\epsilon_0} \frac{|q_1||q_2|}{r^2}$$

ϵ_0 = permittivity constant

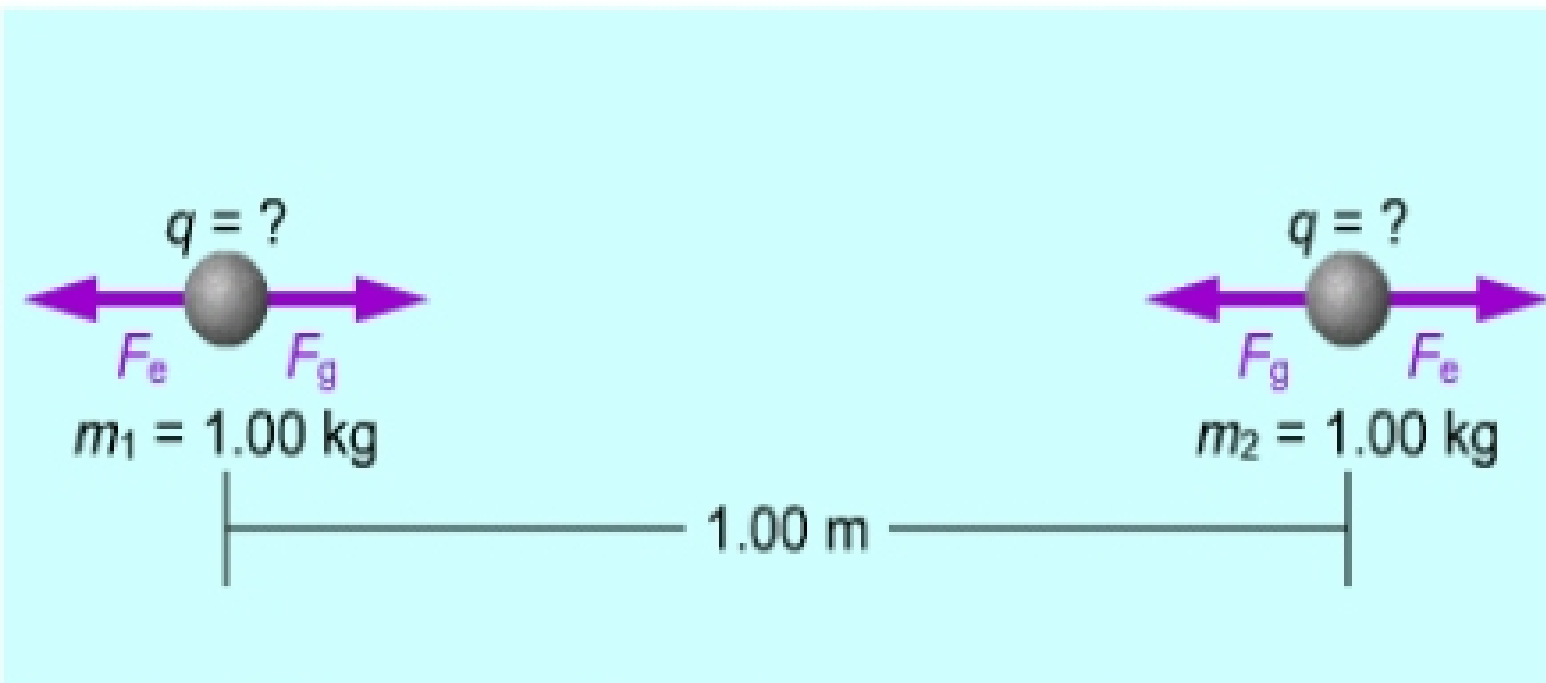
Constant $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2$

Force is a vector.

The direction of the Coulomb force follows

1. The line defined by the two point charges.
2. Like charges repel, unlike charges attract.

- Example 1 of using Coulomb's Law.



The diagram shows two lead spheres, each with mass $m_1 = 1.00 \text{ kg}$ and $m_2 = 1.00 \text{ kg}$, separated by a distance of 1.00 m . Each sphere has an unknown charge $q = ?$. On the left sphere, a purple arrow labeled F_e points to the left and a purple arrow labeled F_g points to the right. On the right sphere, a purple arrow labeled F_g points to the left and a purple arrow labeled F_e points to the right. A horizontal line with vertical end-caps indicates the 1.00 m distance between the centers of the spheres.

How many excess electrons must be added to each neutral lead sphere to balance the force of gravity between them?

gravitational constant

$$G = 6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$$

1. Formula to use:

$$F_e = k \frac{|q_1 \cdot q_2|}{r^2}, \quad F_g = G \frac{m_1 \cdot m_2}{r^2}$$
2. Condition: $F_e = F_g$

$$\text{So } k \frac{|q_1 \cdot q_2|}{r^2} = G \frac{m_1 \cdot m_2}{r^2}$$
3. Known: $q = q_1 = q_2, \quad m = m_1 = m_2 = 1.00 \text{ kg}.$

$$r = 1.00 \text{ m}$$