Electric Field

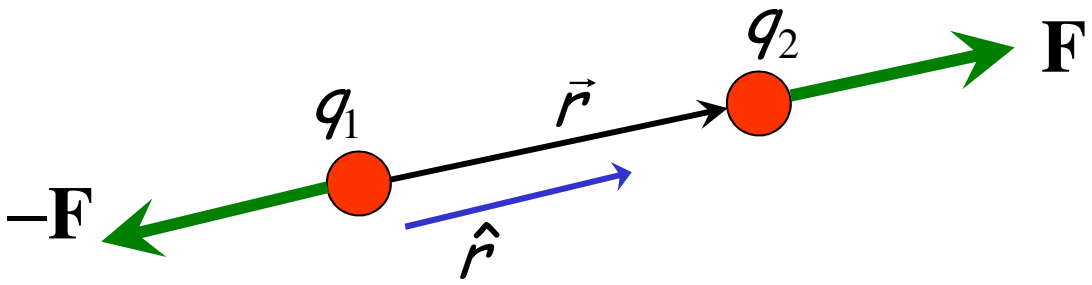
- Coulomb's Law
- Electric Field

Text sections 23.3, 23.4

Practice: Chapter 23 ,
Objective Questions 1, 3, 5, 7
Problems 4, 11, 13, 15

Coulomb's Law

Point charges q_1, q_2 exert forces on each other:

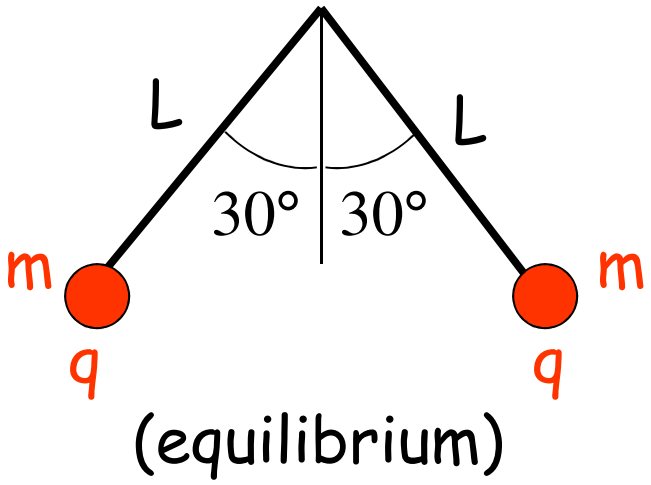


$$\mathbf{F} = k_e \frac{q_1 q_2}{r^2} \hat{\mathbf{r}}$$

$\hat{\mathbf{r}}$ is a unit vector parallel to $\mathbf{r}$

$k_e = 8.988 \times 10^9 \, N \bullet m^2 / C^2$ (Coulomb's Law constant)

Exercise: *(How big are ordinary charges?)*



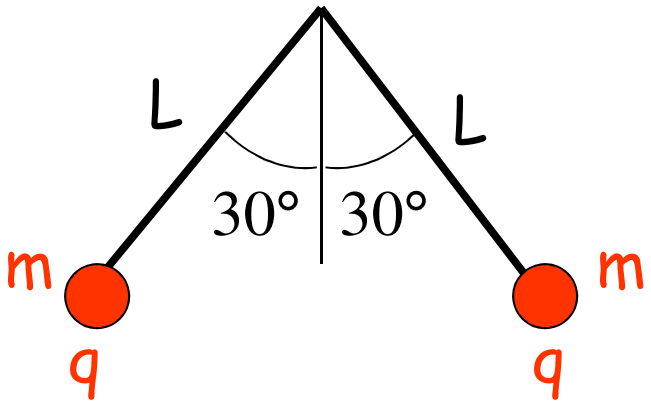
(equilibrium)

GIVEN:

- Identical Masses, m=1.0 gram
- Equal charges q
- L= 60 cm

FIND: q

Review Quiz

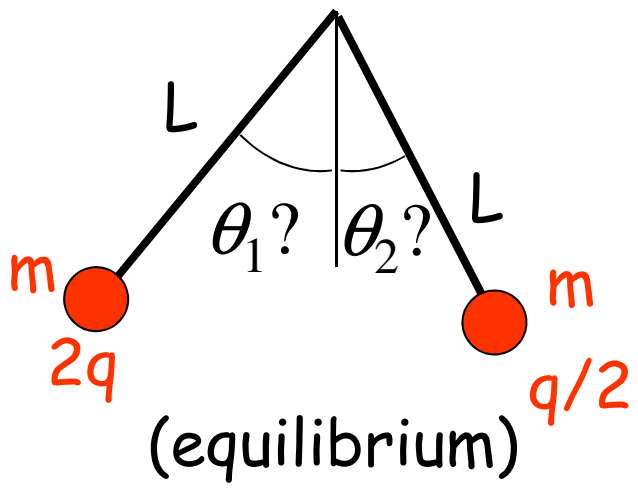


(equilibrium)

The tension in each string is

A) mg
B) $mg \cos 30°$
C) $mg/\cos 30°$
D) $mg \tan 30°$
E) None of the above; it depends on the charge.

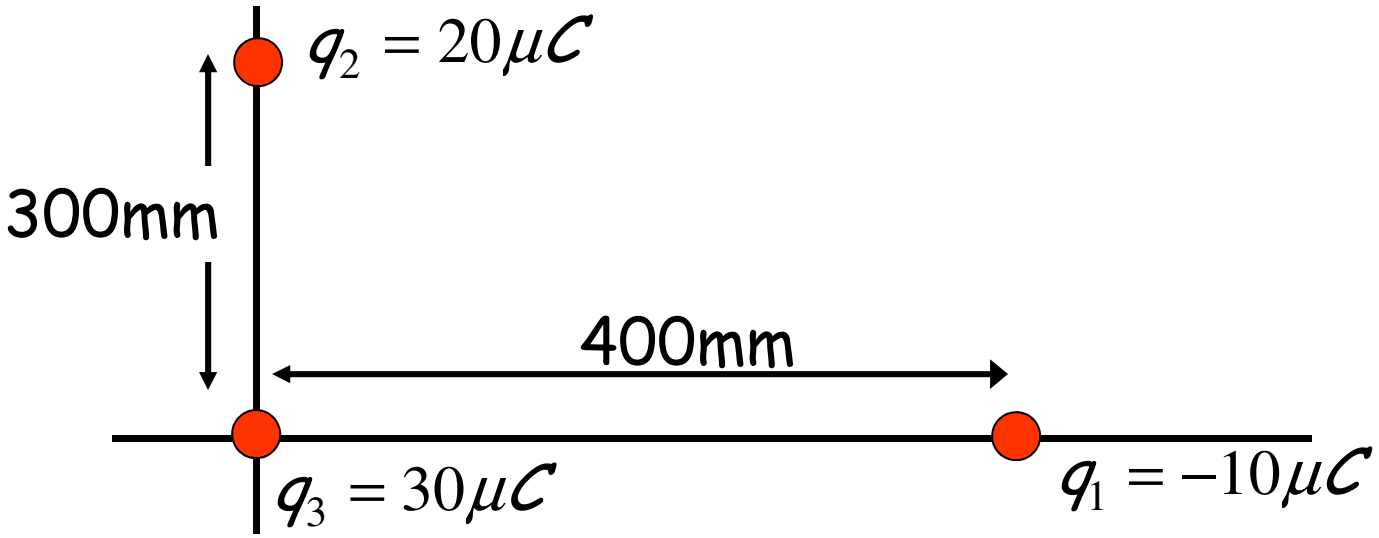
Quiz:



What happens to each angle if the charge on the left is doubled, and the other one is halved?

A) Both increase
B) both decrease
C) θ_1 increases, θ_2 decreases
D) θ_1 decreases, θ_2 increases
E) both stay the same

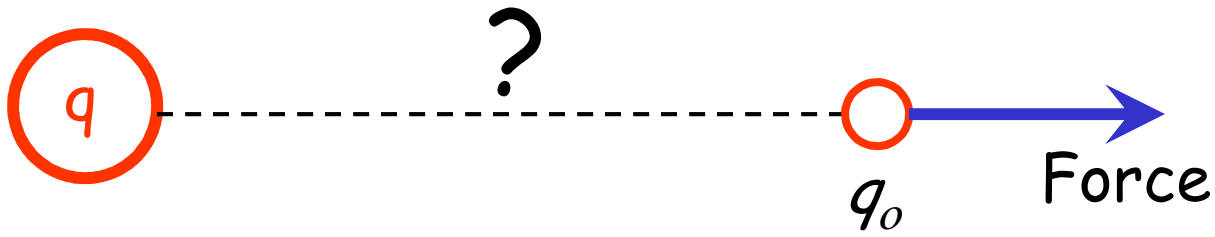
Example:



Find: Force (vector) on q_3, in Cartesian form.

Electric Field $\vec{E}$

Coulomb's Law: "action at a distance"



Field Picture:

1) The "source" charge q produces an electric field in space.

2) Then the field pushes on the "test" charge q_o.

Definition:

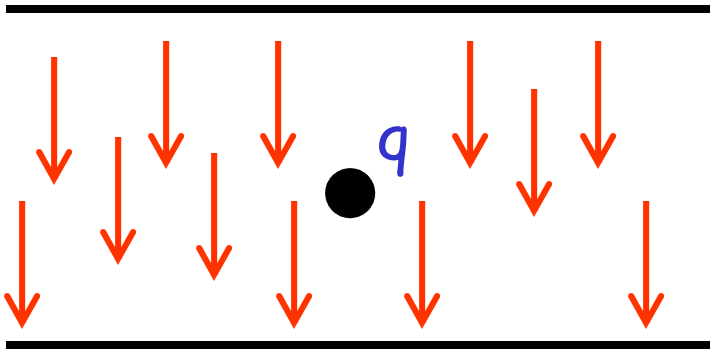
$$\text{Electric Field} \equiv \frac{\text{observed force on "test charge" } q_0}{\text{charge } q_0}$$

$$\vec{E} \equiv \frac{\vec{F}}{q_o}$$

Units: N/C

- A vector
- Exists before test charge is introduced
- Is produced by other charges (not q_0)

Example:



$\vec{E} = 1000\,N/C\,[\downarrow]$

Calculate the force on an alpha particle ($q = +2e$) if it is placed in the field.

Repeat for an electron.

Discussion:

Suppose we do something similar for gravity, and introduce a "gravitational field" to transmit the gravitational force.

1) What would be the units?
2) What would be a typical magnitude and direction of the gravitational field in everyday life?
3) What would be a good algebraic symbol to use?