PHYS 2135
Engineering Physics II

Watch the Introduction Video for a general overview of the course.

Read the Course Handbook for details about course policies and procedures.

Read the Syllabus for the schedule of lectures, homework and exams.

Lab material and schedule provided in Canvas.

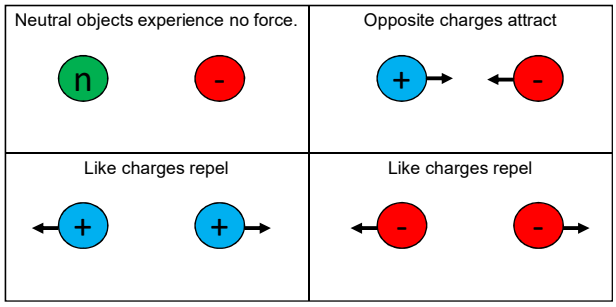
Electric Charge

What is charge?
- Property of matter (similar to mass)
- Describes how strongly objects interact electrically

Two kinds of charge
- Labeled positive and negative
- Like charges repel
- Unlike (opposite) charges attract

Law of Conservation of Charge:
- Net amount of charge does not change in any process

Charged Insulators



Charged Insulators

The force is proportional to the product of the charges.

q_0 and q_0  $F_0 \sim q_0^2$

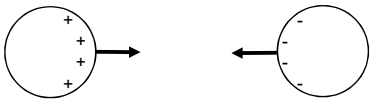
q_0 and $2q_0$  $F_0 \sim 2q_0^2$

$2q_0$ and $2q_0$  $F_0 \sim 4q_0^2$

Charged Conductors

Free charges can move in conductors.

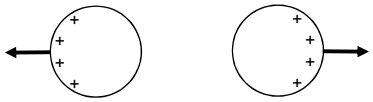
Oppositely charged conductors attract.



Charged Conductors

Free charges can move in conductors.

Like charged conductors repel.



Charged Conductors

Free charges can move in conductors.

Neutral conductors are attracted to charged objects.

Electric Charge

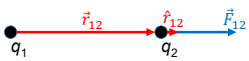
Charge is quantized

- Discrete amounts are multiples of $e = 1.6 \times 10^{-19}$ C
- Protons have positive charge, $+e = +1.6 \times 10^{-19}$C
- Neutrons have no net charge
- Electrons have negative charge, $-e = -1.6 \times 10^{-19}$C

(Atom is not drawn to scale.)

Coulomb's Law

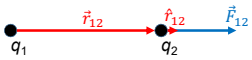
The force on one charge due to another charge.



$$\vec{F}_{12} = k\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12}$$

Coulomb's Law

The force on one charge due to another charge.

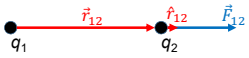


$$\vec{F}_{12} = k\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12}$$

Force due to q_1 acting on q_2.

Coulomb's Law

The force on one charge due to another charge.



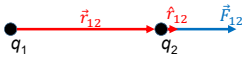
$$\vec{F}_{12} = k\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12}$$

Constant that depends on system of units. Found on OSE sheet.

$$k = 9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2}$$

Coulomb's Law

The force on one charge due to another charge.



$$\vec{F}_{12} = k\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12}$$

Amount and sign of each charge.
Like (unlike) charges → Force is away from (towards) q_1.

Coulomb's Law

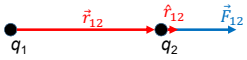
The force on one charge due to another charge.

$$\vec{F}_{12} = k\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12}$$

Square of distance between charges.
Force decreases rapidly as if charges are moved apart.

Coulomb's Law

The force on one charge due to another charge.



$$\vec{F}_{12} = k\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12}$$

Direction vector is away from q_1.

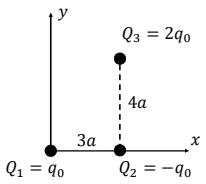
Coulomb's Law

The force on one charge due to another charge.

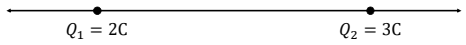
$$\vec{F}_{12} = k\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12} = -k\frac{q_2 q_1}{r_{21}^2}\hat{r}_{21} = -\vec{F}_{21}$$

Newton's Third Law

Example: Three charges are arranged as follows. $Q_1 = q_0$ is at the origin, $Q_2 = -q_0$ is at $(3a, 0)$ and $Q_3 = 2q_0$ is at $(3a, 4a)$. Determine the force acting on Q_3.



Example: Q_1 = 2C is held fixed at x = 0. Q_2 = 3C is held fixed at $x = d$, where d is positive. Where along the x-axis could Q_3 be placed so that it is in equilibrium?



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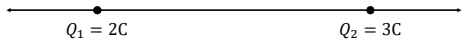

Is Q_3 in stable or unstable equilibrium?