UBC Physics 102

Lecture 4

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Outline

Electric charge [Text: Sect. 21-1,2,3,5]

- **Definition:** *electric charge*
  - Property of matter that can create force.
  - Two types of charge: $+$ or $-$.
  - Unlike charges attract, like charges repel.
- **Principle: Charge conservation**
  - Net electric charge never changes.
  - If charge increases somewhere then opposite charge must also increase somewhere else so that net change is always zero!
- **Definition:** *Ion*
  - Atom with nonzero charge.

Electric charge, contd

- **Definition:** *Conductor*
  - Material that allows transmission of ("conducts") charge.
  - Has many "free" electrons.
- **Definition:** *Insulator*
  - Nonconducting material, prevents transmission of charge.
  - Electrons are tightly bound to molecules.
- **Interactive Quiz: PRS 04a**

Electric charge, contd

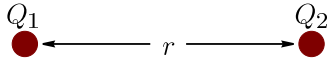
- **Definition:** *Coulomb,* C
  - Unit of charge, indicates amount of charge on an object.
- **Definition:** *Elementary charge,* e

$$e = 1.60 \times 10^{-19}\ \mathrm{C}.$$

  - Smallest magnitude of charge any object can hold.
  - Electron has charge $-e$, proton has $+e$.
  - All charges come in integer multiples of e.

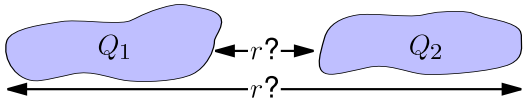
Coulomb's law [Text: Sect. 21-5]

- **Definition:** *Coulomb's law*
  - Gives force two charges exert on each other.



$$F = k\frac{Q_1 Q_2}{r^2}.$$

  - Positive force means repulsion, negative means attraction.
  - Only works for objects whose sizes are much smaller than r. Otherwise, how do you choose r?



Coulomb's law, contd

- **Definition:** *Coulomb constant*
  - Proportionality constant in Coulomb's law,

$$k = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9\ \mathrm{N \cdot m^2/C^2}.$$

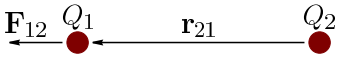
- **Definition:** *Permittivity of free space*

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

  - Most equations look simpler if we use ϵ_0 instead of k (except Coulomb's law).

Vector form of Coulomb's law

- **Interactive Quiz: PRS 04b**
- **Definition:** *Vector form of Coulomb's law*
  - Incorporates direction of force in vector notation,



$$\mathbf{F}_{12} = k\frac{Q_1 Q_2}{r^2}\hat{\mathbf{r}}_{21}.$$

  - $\mathbf{F}_{12}$ = force on 1 due to 2.
  - $\hat{\mathbf{r}}_{21}$ = unit vector from 2 to 1.
  - If confused, remember likes charges repel, opposites attract.

End

- **Interactive Quiz: PRS 04c**
- **Practice Problems:**
  - Ch. 21: Q. 5, 7, 9, 13
  - Ch. 21: Pr. 1, 3, 5, 7, 17, 21, 67, 69
- **Interactive Quiz: Feedback**