Copyright statement

- The images and the pictures in this lecture are provided by the CDs accompanied by the books

  1. University Physics, Bauer and Westfall, McGraw-Hill, 2011.
  2. Principles of Physics, Halliday, Resnick, and Walker, Wiley, 8th and 9th Ed.

- The rest is made by me.

General Physics II

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상담시간: 언제나

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Topics to cover in the fall

- All about electromagnetism
- Electricity: Chap. 21 - 26
- Magnetism: Chap. 27 – 29
- Maxwell Eq. and EM waves: Chap. 30 – 31
- Wave optics: Chap. 34
- Modern Physics: Chap. 36-37
- * Special relativity EXCLUDED

Laws of electromagnetism from Maxwell Equations

(1) Coulomb's law: Force between charges

very similar to gravity $F \propto \frac{q_1 q_2}{r^2}$

(2) Gauss' law: Relation between charges and electric field. $1/r^2$ force

(3) Faraday's induction law의 유도법칙

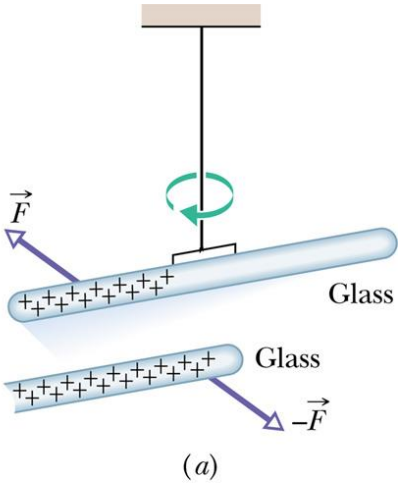
Time change of B inducing change of E

(4) Ampere-Maxwell's law

Time change of E inducing change of B

Chap. 21 Coulomb's Law

electric charge

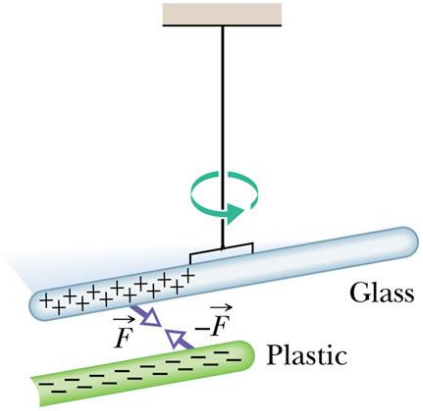


(a)

The same kinds of charges repel.

2 kinds of charges
+,-: Benjamin Franklin

Gravity only pulls.
Gravity has only one kind of charge-mass.
Weak interaction: 3 kinds
Strong interaction: 8 kinds



(b)

Opposite kinds of charges attract.

Electrostatic force is called Coulomb force.

Conductors and insulators

Classification of matter by charge flow

- conductor

  Internal electric charges move freely. (metal, salt water, human body)

- nonconductor, or insulator

  All the electrons are bound by nuclei, and the current cannot flow

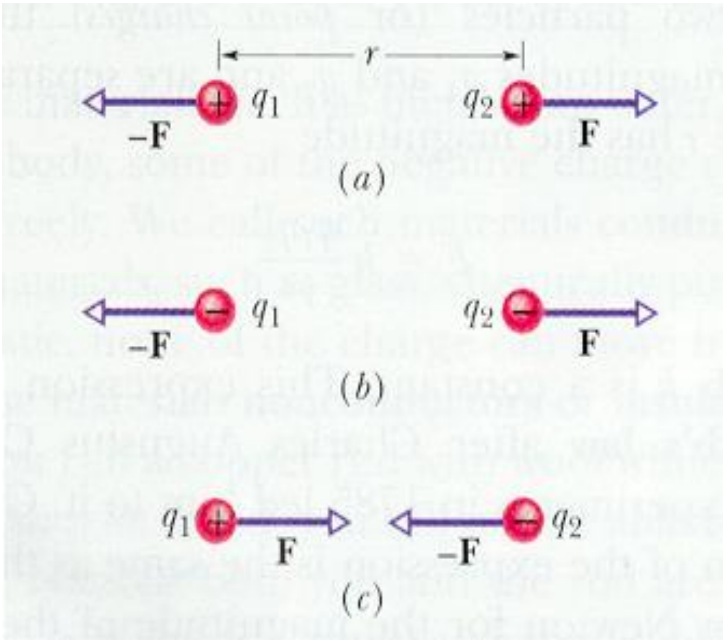
- semiconductor

  Current flows in one direction only. (Si, Ge)

- superconductor

  No resistance

Coulomb's law



$$F \propto \frac{1}{r^2}, F \propto q_1 q_2 \leftarrow \text{실험적 사실}$$

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

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

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

유전상수 (permittivity constant) $\epsilon_0 = 8.85 \times 10^{-12} \ \mathrm{C^2/N \cdot m^2}$

1 C (Coulomb)이란?

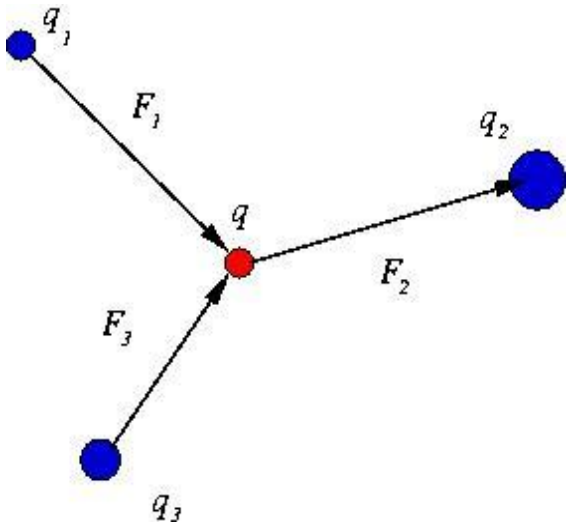
SI 단위계에서 도선을 통해 1 A(암페어)의 전류가 1 초 동안 흐른 전하의 양. $(dq = idt)$

전하는 양자화(quantize)되어 있으며 항상 전자의 전하 $e = 1.6 \times 10^{-19}$ C의 정수배로만 존재한다.

N.B. gravity

$$\mathbf{F} = G\frac{m_1 m_2}{r^2}\hat{\mathbf{r}}$$

Comments on the Coulomb force

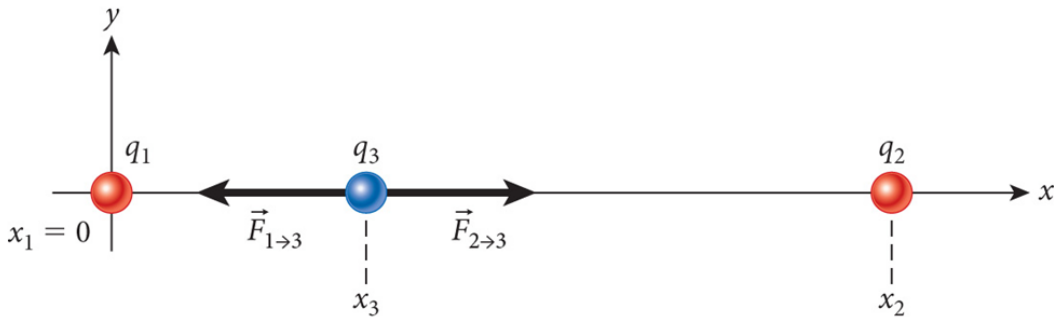


- 중첩의 원리: $\mathbf{F}_{\text{net}} = \mathbf{F}_1 + \mathbf{F}_2 + \cdots$
- 껍질정리 (shell theorem): 중력과 마찬가지로 $1/r^2$ 힘인 경우에는 항상 성립.

전하보존 (electric charge conservation)

자연계의 어떤 과정에서도 전하는 보존된다.
$e^+ + e^- \to \gamma\gamma$, $n \to p + e^-$ 등등

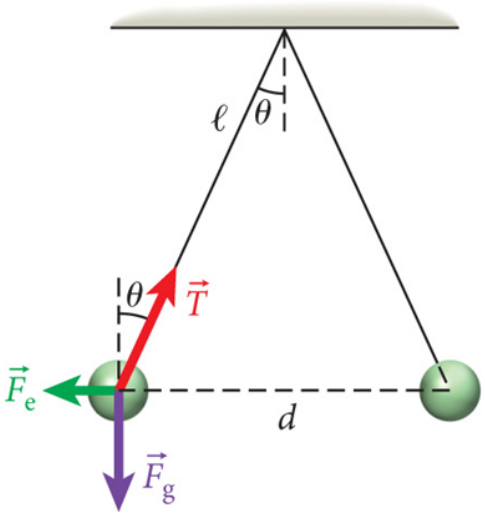
Example 21.3 Equilibrium position

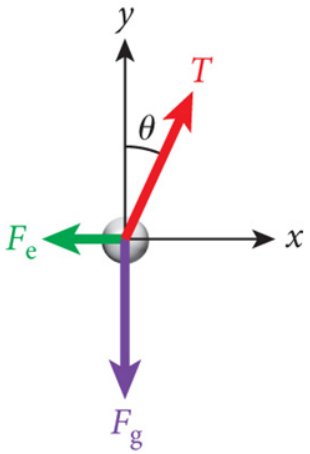


$q_1 q_2 > 0$

$q_1 q_2 < 0$

Solved prob. 21.1: charged balls

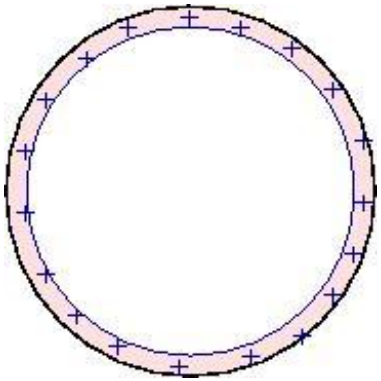




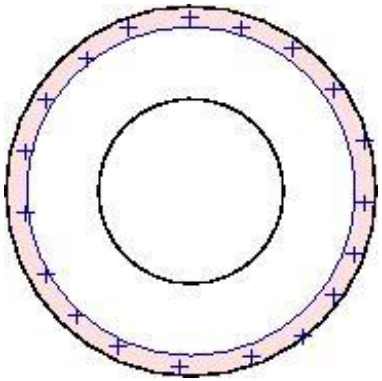
$m = ?$

Charge distribution in a conductor

Solid conducting sphere



Hollow conducting sphere



도체 안에서는 전자가 힘을 받기만 하면 자유롭게 움직인다. 따라서 속이 꽉 찬 공 모양이나 속이 빈 공모양의 도체 안에서는 전하들은 항상 겉표면에 균일하게 분포한다.

Earth

지구는 매우 크므로 무한한 전하를 공급할 수 있는 것으로 본다.