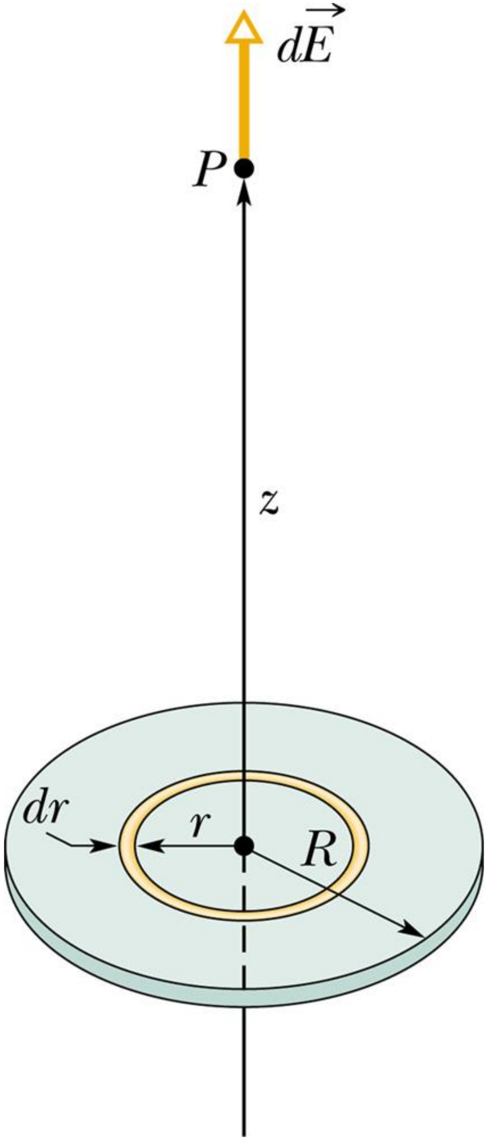
Copyright statement

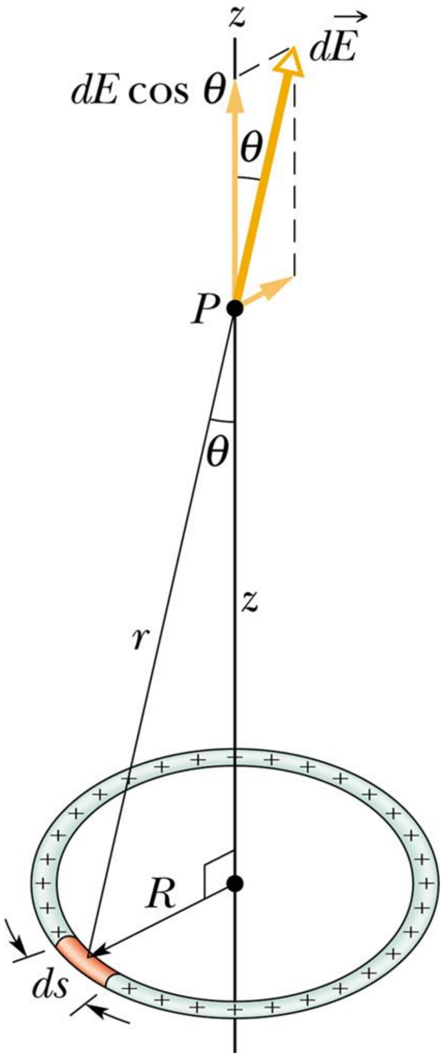
- The images and the pictures in this lecture are provided by the CDs accompanied by the books
  1. University Physics, Bauer and Westfall, McGraw-Hill, 2011.
  2. Principles of Physics, Halliday, Resnick, and Walker, Wiley, 8^{th} and 9^{th} Ed.
- The rest is made by me.

charged disk



$$E = \frac{\sigma}{2\epsilon_0}\left(1 - \frac{z}{\sqrt{z^2 + R^2}}\right)$$

고리전하



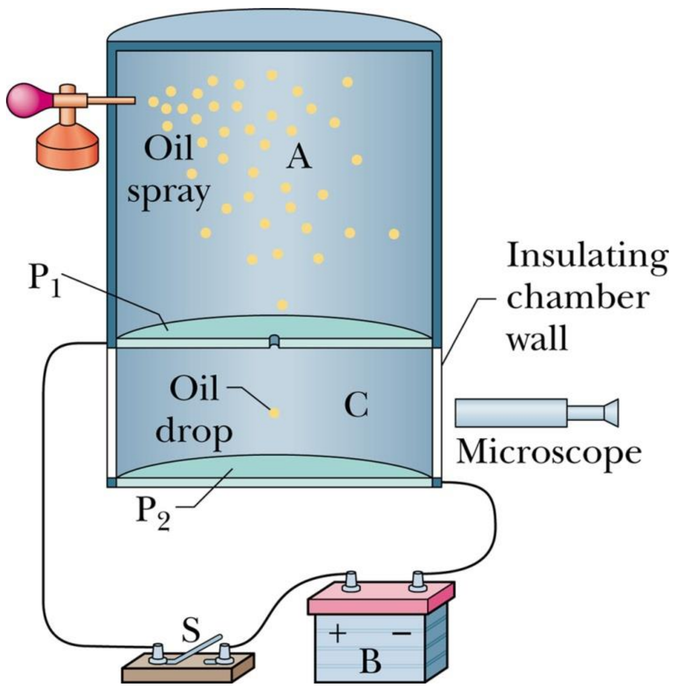
$$E = \frac{qz}{4\pi\epsilon_0(z^2 + R^2)^{3/2}}$$

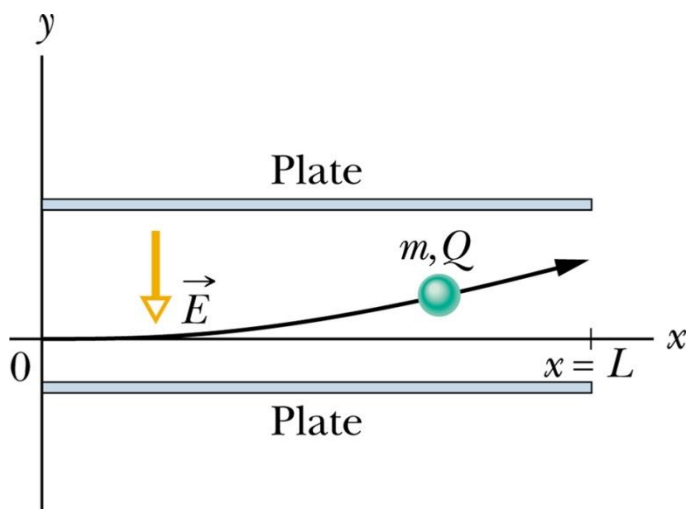
Point charge in uniform E

Millikan's experiment

$$\mathbf{F} = q\mathbf{E}$$

Inkjet printing





$m = 1.3\times10^{-10}$ kg

$q = -1.5\times10^{-13}$ C

$v_x = 18$ m/s

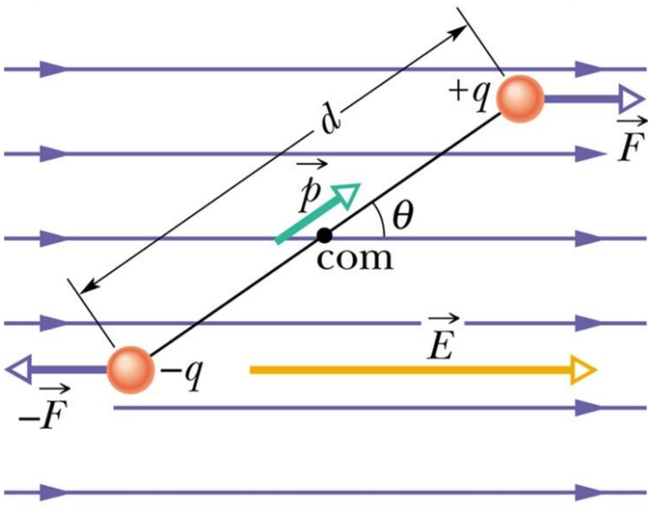
$$a_y = \frac{F}{m} = \frac{qE}{m}$$

$$y = \frac{1}{2}a_y t^2, \;\; L = v_x t$$

$$q = ne \quad (n = 0, \pm1, \pm2, \cdots)$$

$$y = \frac{qEL^2}{2mv_x^2} = 6.4\times10^{-4}\ \mathrm{m}$$

Electric dipole moment in E



(a)

$$\tau = Fx\sin\theta + F(d-x)\sin\theta = Fd\sin\theta$$

$$F = qE, \quad p = qd$$

$$\tau = pE\sin\theta$$

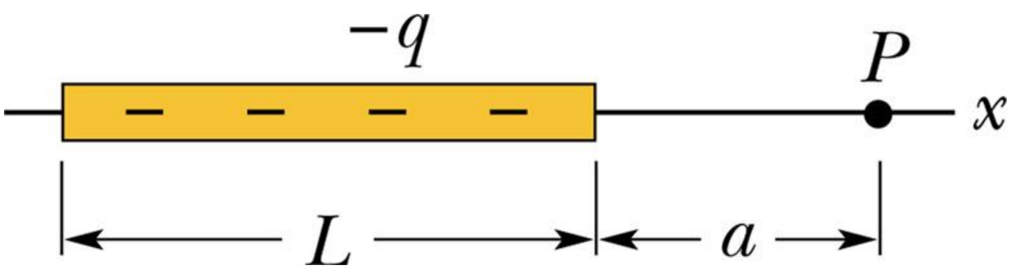
$$\boxed{\tau = \mathbf{p} \times \mathbf{E}}$$

(b)

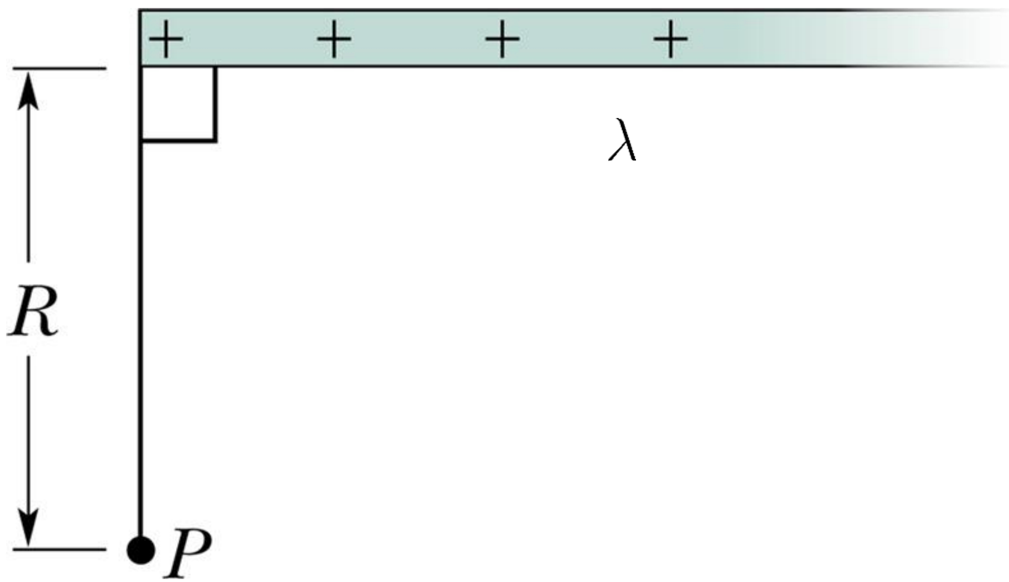
Potential energy of an electric dipole

$$U = -W = -\int_{\pi/2}^{\theta} \tau d\theta = \int_{\pi/2}^{\theta} pE\sin\theta d\theta = -pE\cos\theta \rightarrow -\mathbf{p}\cdot\mathbf{E}$$

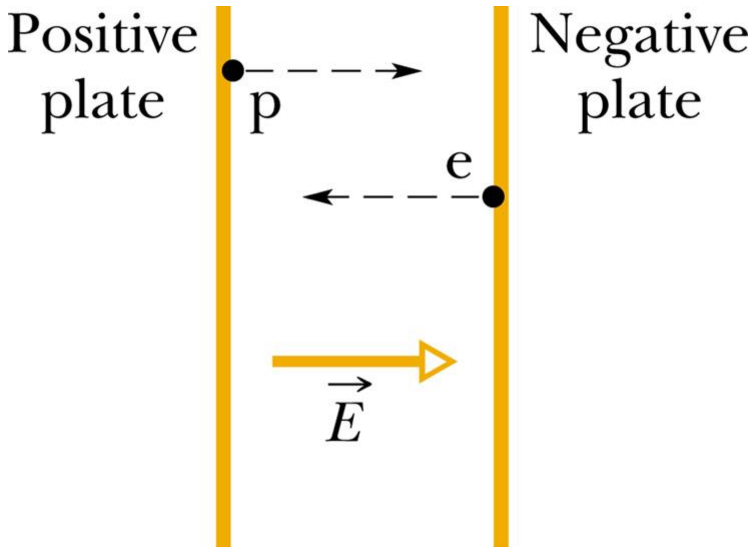
Problem 2



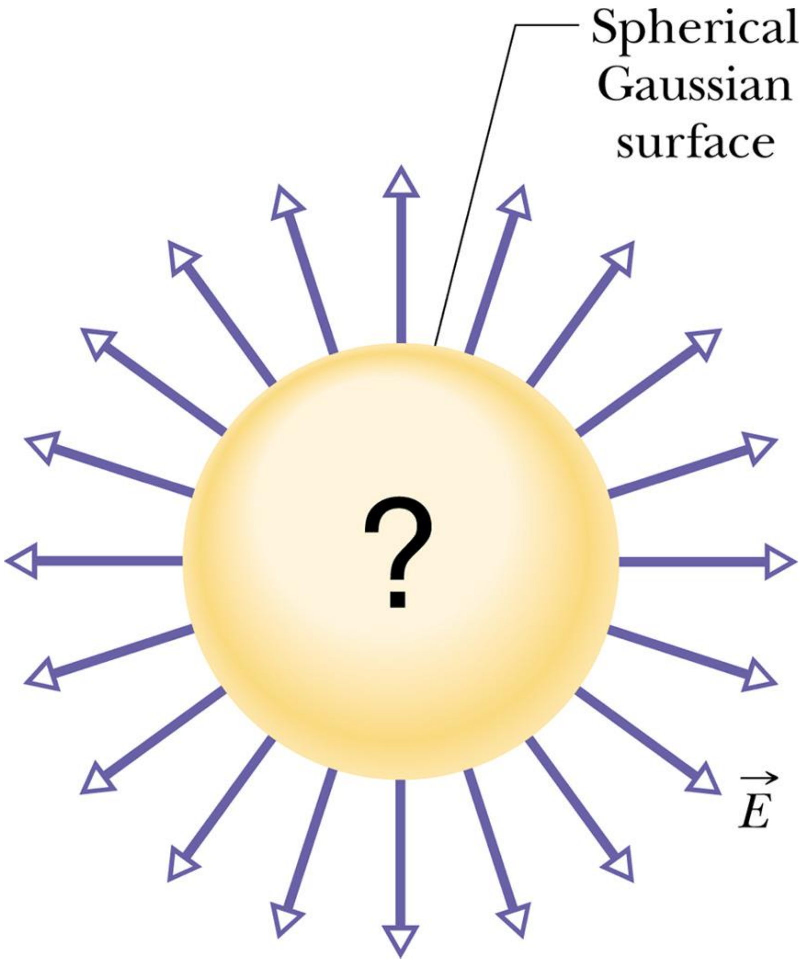
Problem 3



Problem 4



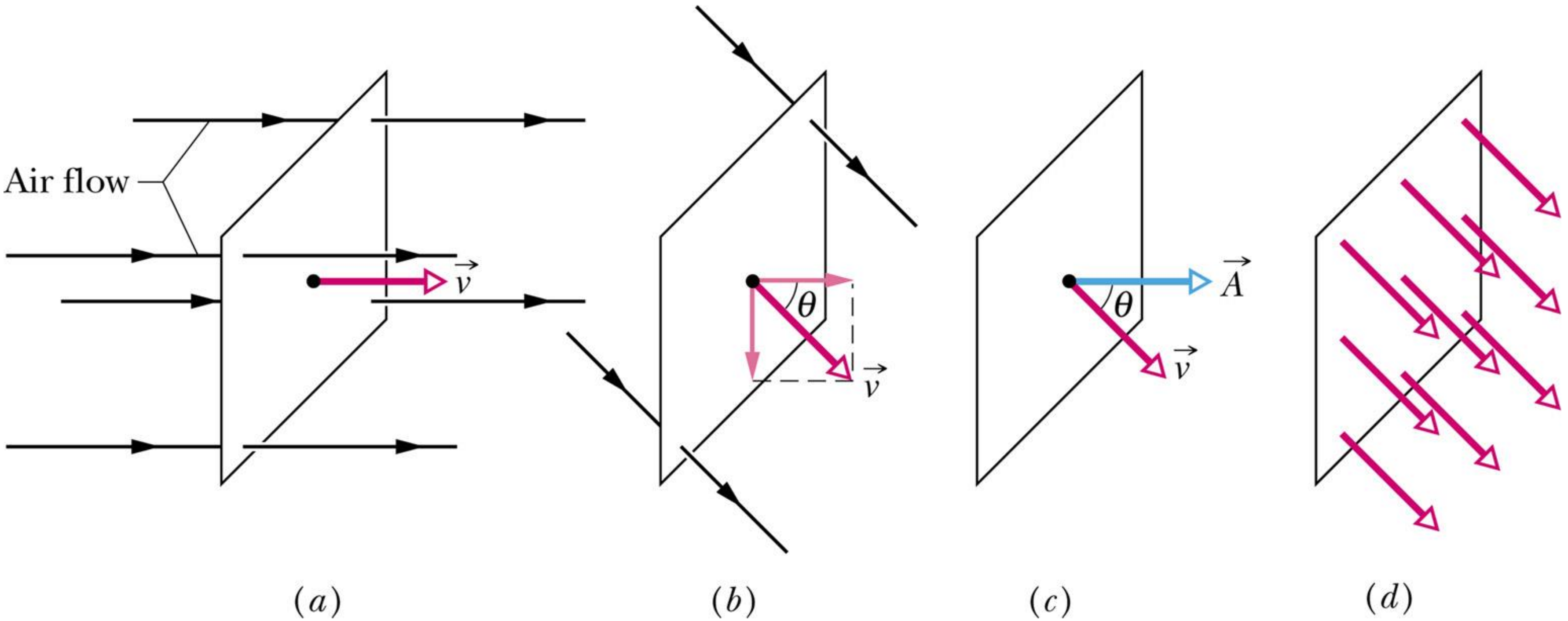
What is Gauss law?



Gauss law

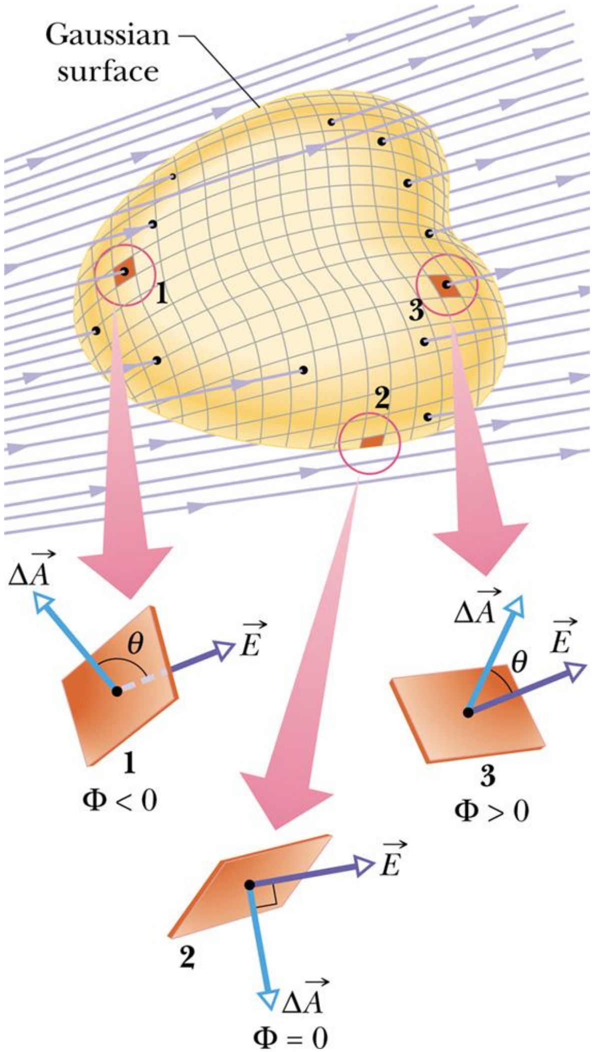
- 대칭성이 있는 전하의 분포에 대해 전기장을 구하는 방법

Flux



$$\Phi = (v\cos\theta)A = \vec{v}\cdot\vec{A}$$

electric field flux



$$\Delta\Phi = \vec{E}\cdot\Delta\vec{A}$$

$$\Phi = \sum \vec{E}\cdot\Delta\vec{A}$$

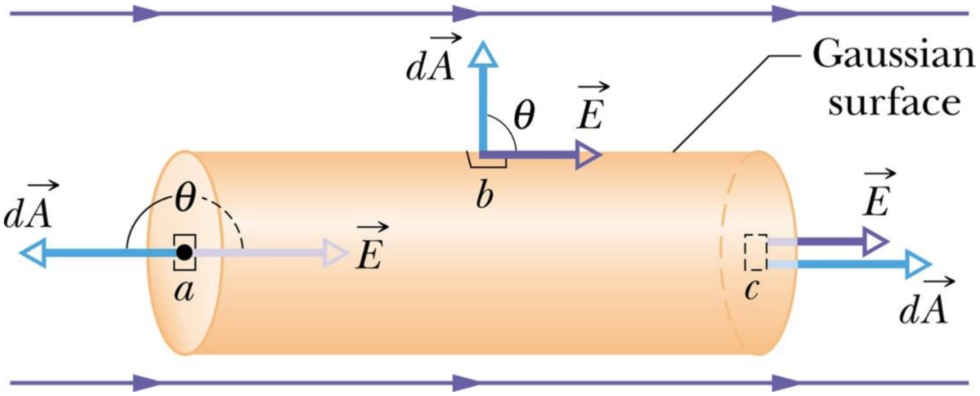
$\Delta\vec{A} \to 0$ 인 극한을 취하면

$$\Phi = \oint \vec{E}\cdot d\vec{A}$$

SI 단위: $\mathrm{N}\cdot\mathrm{m}^2/\mathrm{C}$

전기다발은 Gauss 폐곡면 안의 전하량과 관련이 있다.

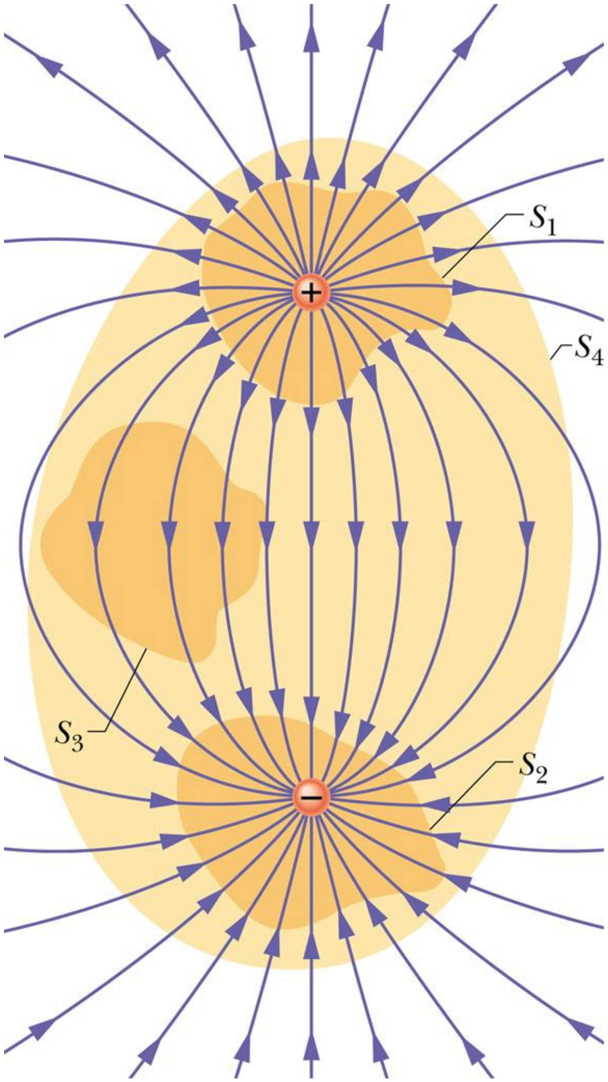
Example 1



$$\Phi = \oint \vec{E} \cdot d\vec{A} = \int_a \vec{E} \cdot d\vec{A} + \int_b \vec{E} \cdot d\vec{A} + \int_c \vec{E} \cdot d\vec{A}$$

Gauss law

$$\epsilon_0 \Phi = q_{\text{enc}}$$



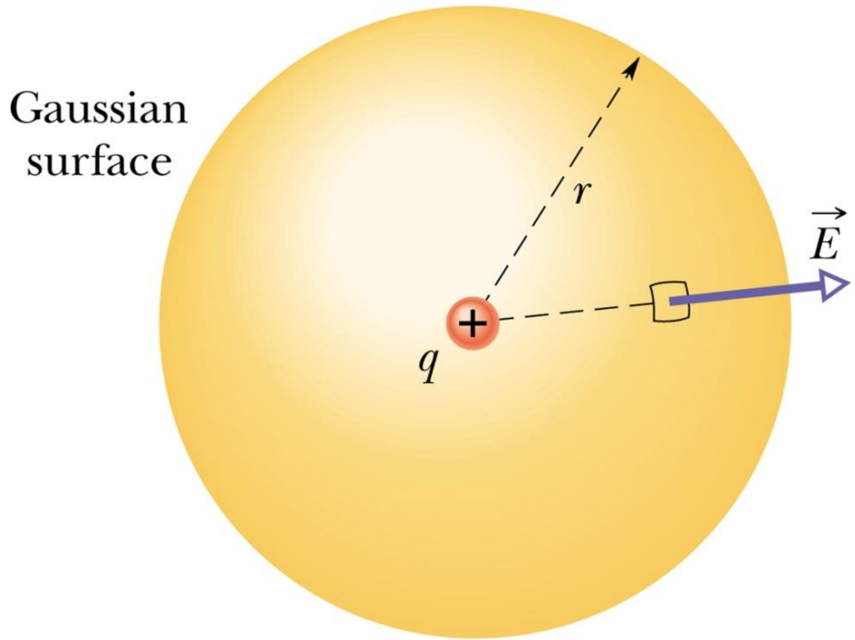
$q_1 > 0 \rightarrow \Phi_1 > 0$

$q_4 = 0 \rightarrow \Phi_4 = 0$

$q_3 = 0 \rightarrow \Phi_3 = 0$

$q_2 < 0 \rightarrow \Phi_2 < 0$

Gauss law & Coulomb's law



$$\epsilon_0 \oint \vec{E} \cdot d\vec{A} = \epsilon_0 \oint E dA = q_{enc}$$

$$\epsilon_0 E \oint dA = \epsilon_0 E (4\pi r^2) = q$$

$$E = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$$

Gauss 폐곡면 똑똑하게 잡기
(1) 대칭성을 생각할 것
(2) $\vec{E} \cdot d\vec{A}$를 계산하기 쉽게 잡을 것
(3) 계산하기