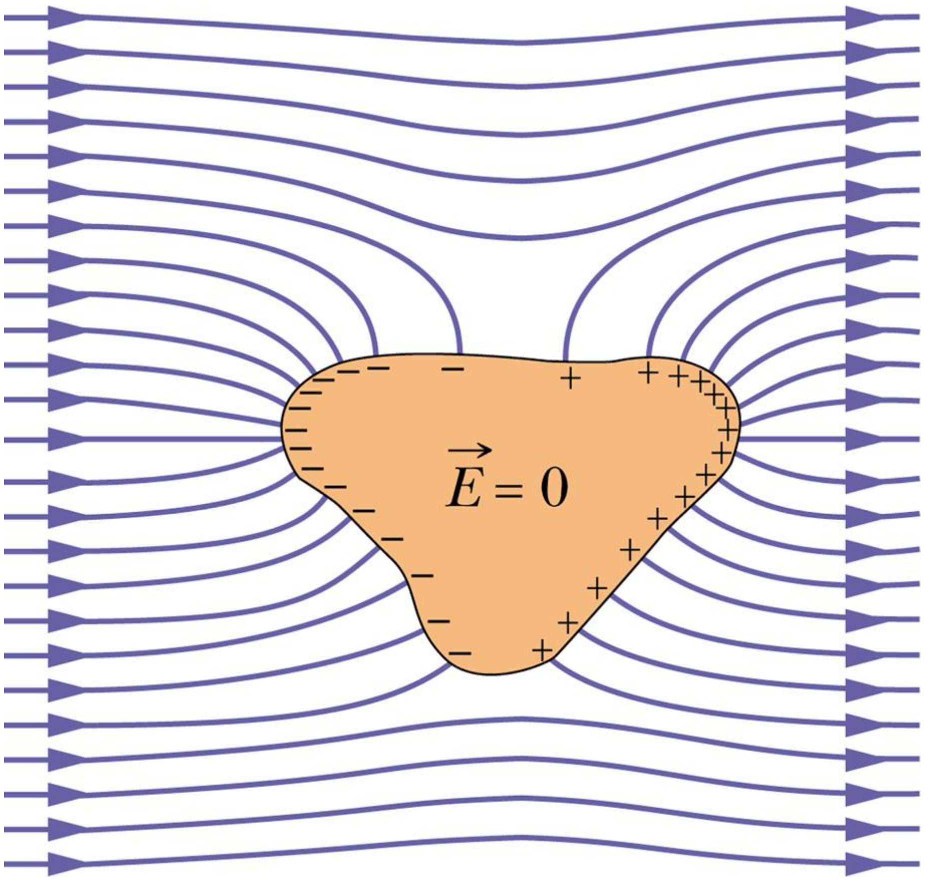
Copyright statement

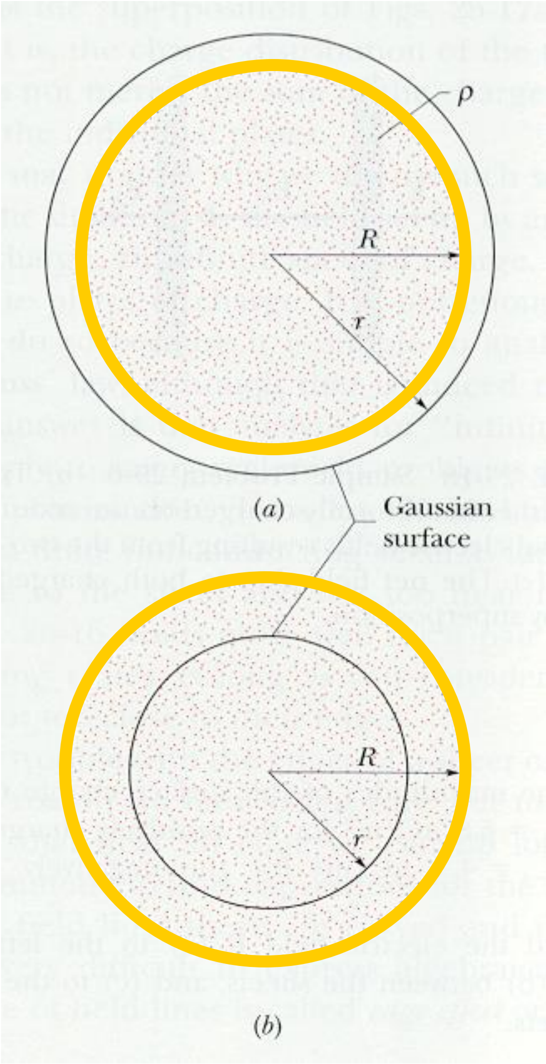
- The images and the pictures in this lecture are provided by the CDs accompanied by the books
  1. University Physics, Bauer and Westfall, McGraw-Hill, 2011.
  2. Principles of Physics, Halliday, Resnick, and Walker, Wiley, 8th and 9th Ed.
- The rest is made by me.

Isolated conductor in an external E



Surface of a conductor is an equipotential surface, hence normal to the electric field.

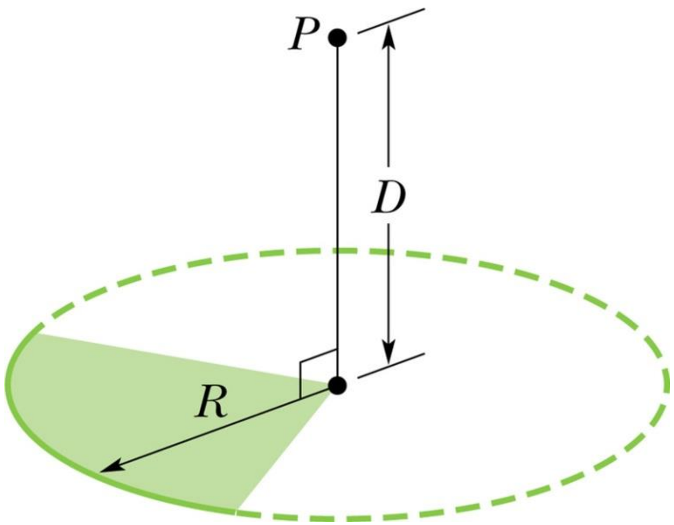
Insulating sphere



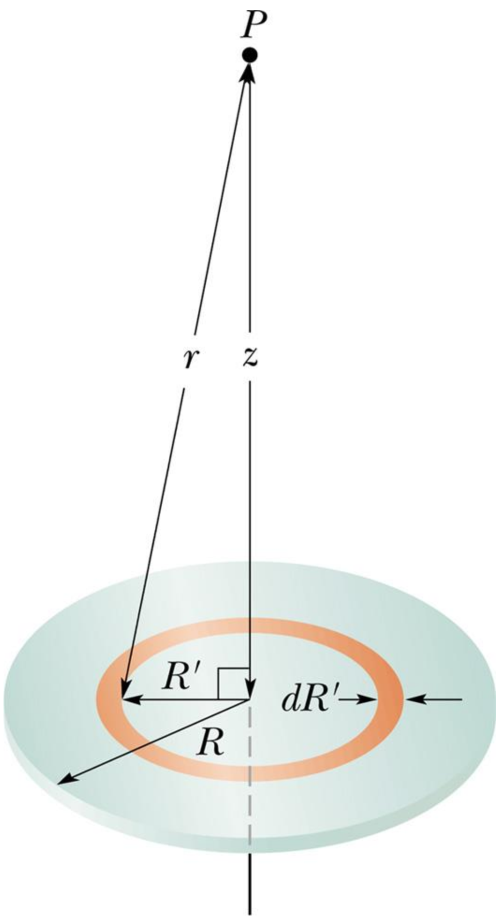
$$r > R; \qquad E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$$

$$r < R, \qquad E = \frac{1}{4\pi\varepsilon_0}\frac{q}{R^3}r$$

Problem 1



Surface charge

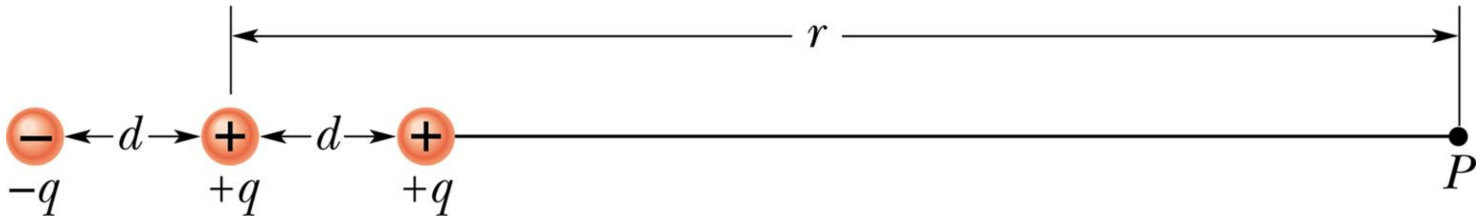


$$V = \frac{\sigma}{2\epsilon_0}\left(\sqrt{z^2 + R^2} - z\right)$$

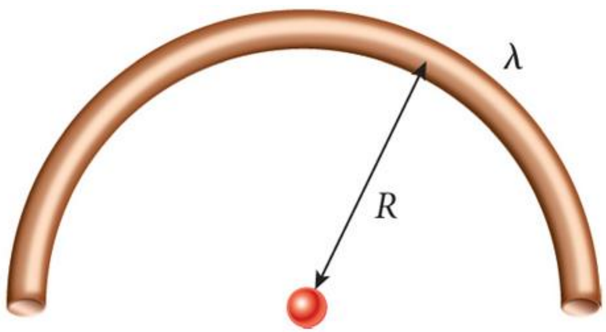
반지름 R인 부도체 구에 전하 q가 균일하게 분포되었을 때의 퍼텐셜에너지는?

$$U = \frac{1}{4\pi\epsilon_0}\frac{3q^2}{5R}$$

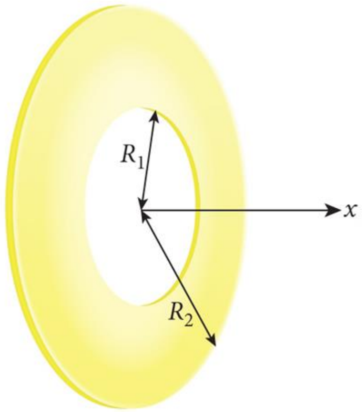
Problem 2



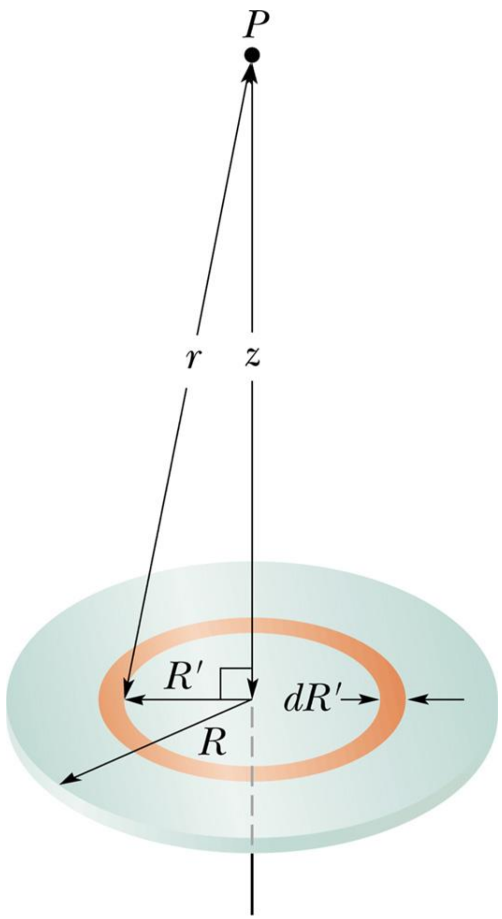
Problem 3



Problem 4

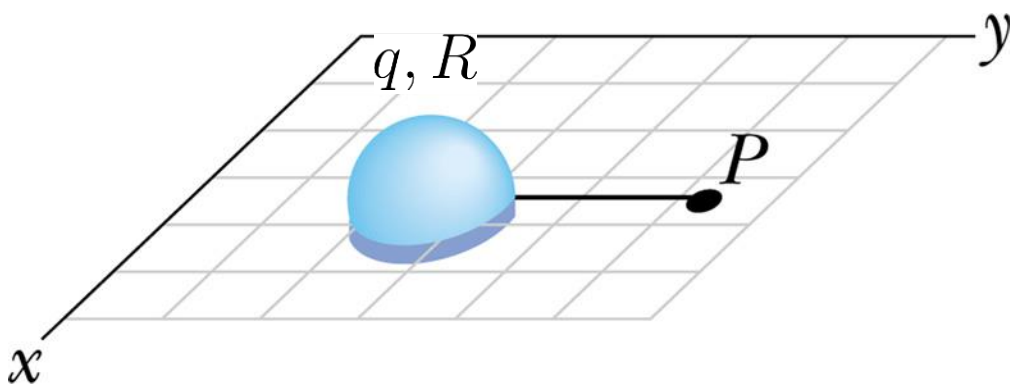


Surface charge



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

Problem 5



Chap 24. Capacitors

Topics in chapter 24

(1) Concepts of capacitor and capacitance

(2) Computation of capacitance: parallel plate, cylinder, circle, sphere

(3) parallel and series connections of capacitors

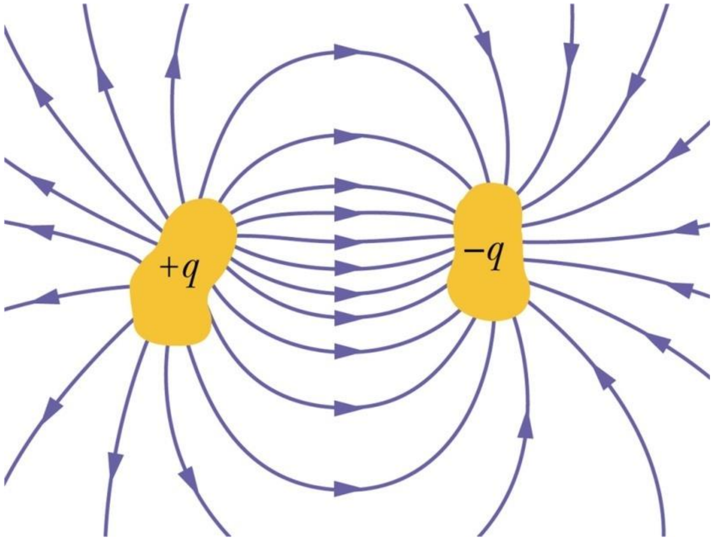
(4) Calculation of the electric energy stored in a capacitor:

energy density of an electric field

(5) Capacitor with dielectric material:

electric property of dielectric material and dielectric constant

Capacitance



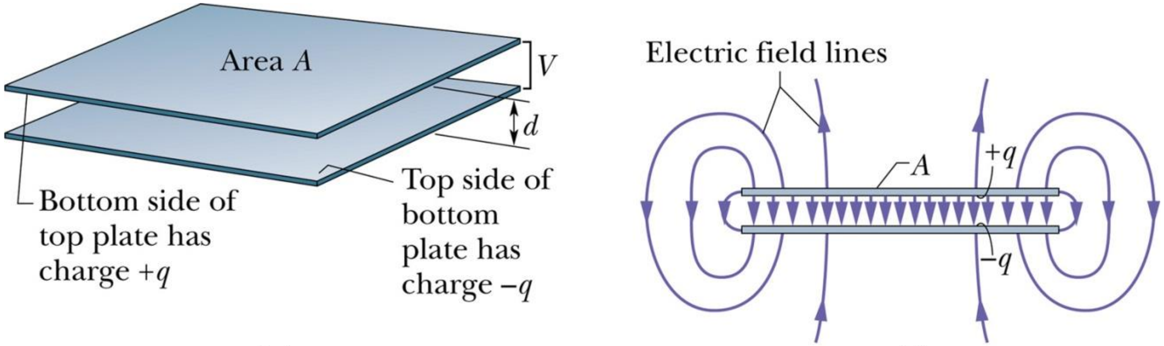
Capacitor
전기적으로 고립되어 있는 떨어져 있는 두 도체

$$q = CV$$

C capacitance

SI unit
1 farad = 1 F = 1 C/V

1. Electric charges reside on the surface.
2. Conductor surfaces are equipotential surfaces.



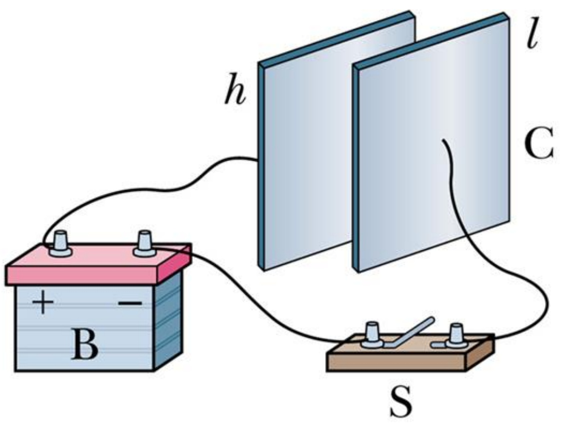
(a) (b)

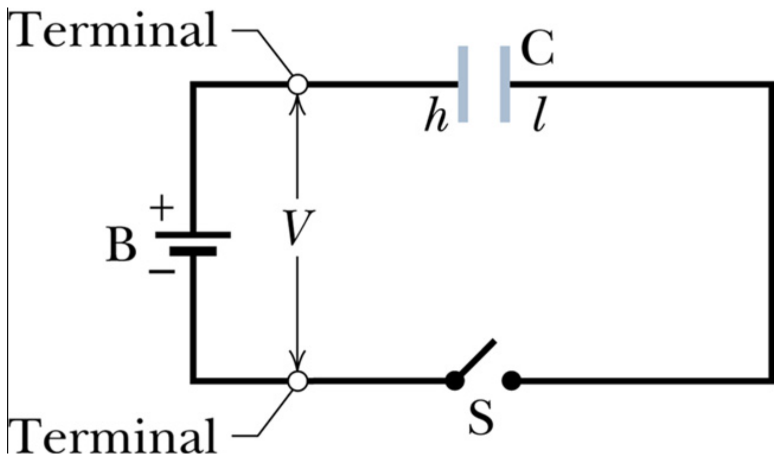
Electric capacitance can be always written in a form $C = \epsilon_0 L$.

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

This can be written as follows:

$$\epsilon_0 = 8.85 \times 10^{-12} \mathrm{F/m} = 8.85 \mathrm{pF/m}$$





Computation of capacitance

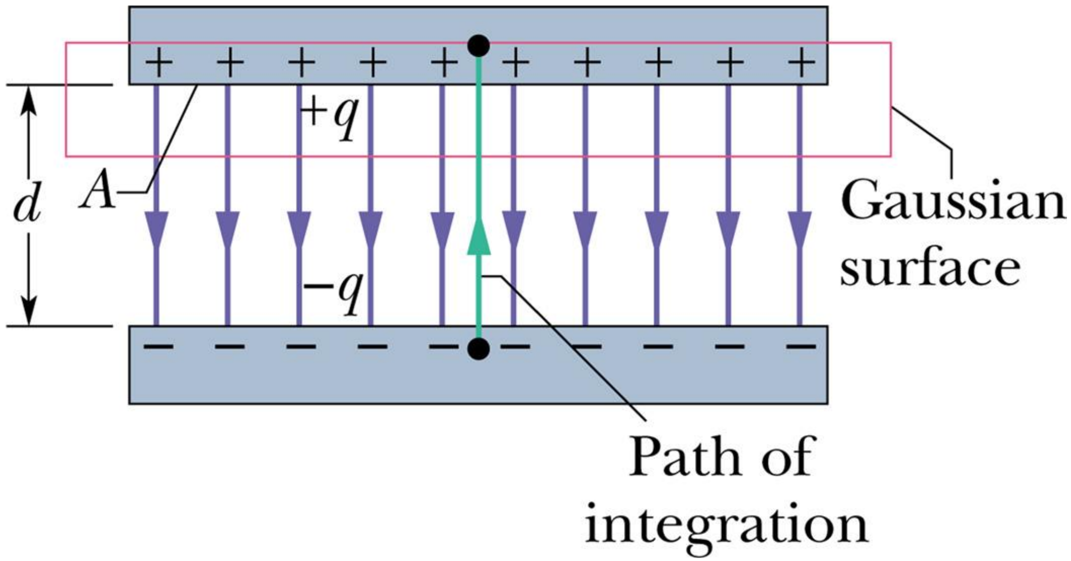
1. 도체 한 쪽에 전하 q, 다른 쪽에 전하 –q를 놓는다.
2. 두 전하 사이의 electric field를 계산한다.
3. Potential difference를 구한다.

Electric field
$$\epsilon_0 \oint \vec{E} \cdot d\vec{A} = q$$

Electric potential difference
$$V_f - V_i = -\int_i^f \vec{E} \cdot d\vec{s}$$

$$C = \frac{q}{|\Delta V|}$$

Parallel capacitor

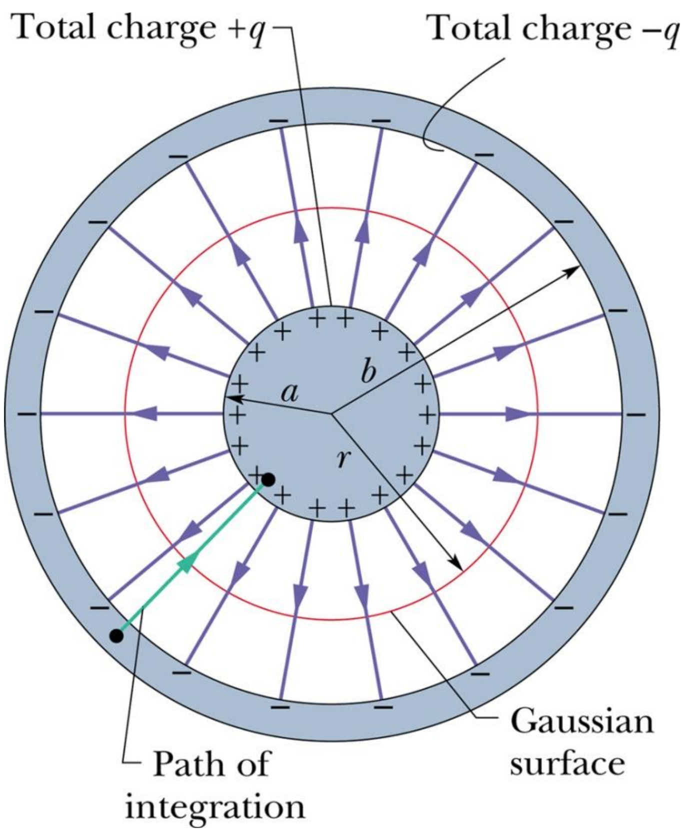


$$\epsilon_0 \oint \vec{E} \cdot d\vec{A} = q \quad \longrightarrow q = \epsilon_0 E A$$

$$V_f - V_i = -\int_i^f \vec{E} \cdot d\vec{s} \quad \longrightarrow V = \int_-^+ E ds = E \int_-^+ ds = Ed$$

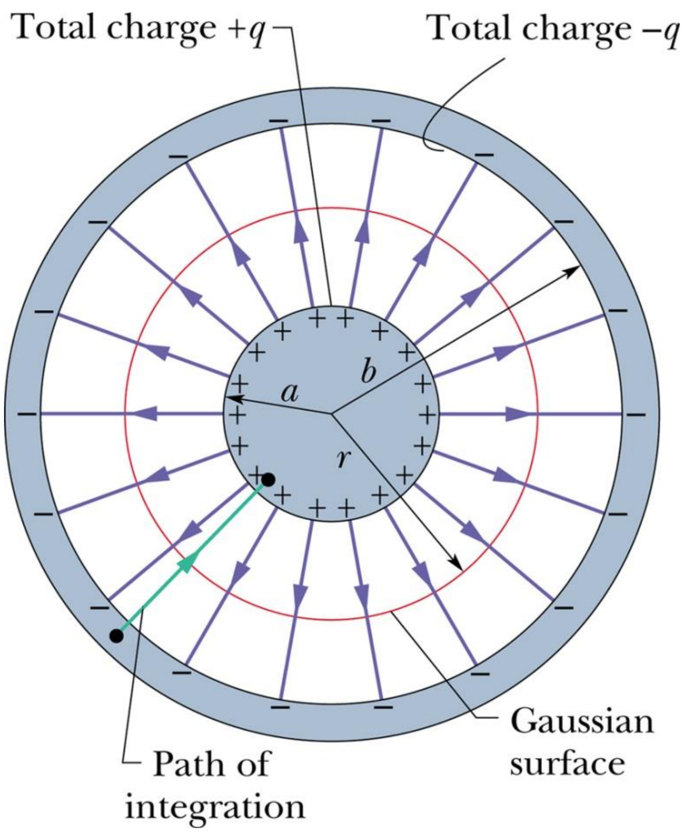
$$C = \frac{\epsilon_0 A}{d}$$

Cylindrical capacitor



$$C = 2\pi\epsilon_0 \frac{L}{\ln(b/a)}$$

Spherical capacitor



$$C = 4\pi\epsilon_0 \frac{ab}{b-a}$$

고립된 공 $C = 4\pi\epsilon_0 R$