Lecture 14

Monday, 24 February 2020 2:06 AM

Our class today will be short. We will only cover some theoretical ideas. As soon as we cover capacitance, we will do a lot of problems.

Conductor (perfect)

has enough free charge that any $\vec{E}$ field applied will almost immediately be countered by charge redistributing itself on the conductor.

We only worry about the case when charge has completely redistributed and everything has stopped moving.

$\therefore$

i) $\vec{E} = 0$ inside a conductor (otherwise charges move till electrostatics case is reached)

ii) $\rho = 0$ inside conductor $(\vec{\nabla} \cdot \vec{E} = \rho/\varepsilon_0)$

iii) Any net charge resides on surfaces

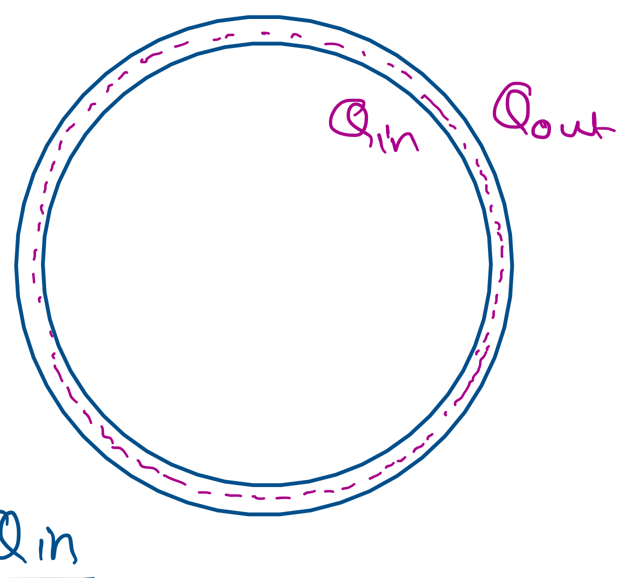
iv) A conductor surface is equipotential.

v) E is $\perp$ to the surface just outside the conductor.

⊛ Consider a spherical conducting shell with radius R and net charge Q. How will the charge distribute on the conductor?

→ As setup is spherically symmetric, charge distribution will be spherically symmetric too.

$\therefore$ the only way to do this is



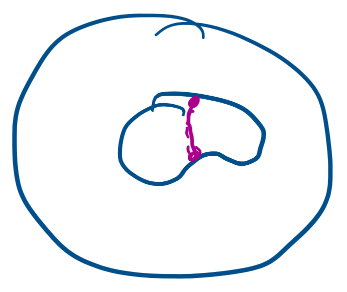
$$\oint \vec{E} \cdot d\vec{a} = \frac{Q_{in}}{\varepsilon_0}$$

As $E = 0 \Rightarrow Q_{in} = 0$

$\therefore \quad Q_{out} = Q$

If a conductor has a cavity the $\vec{E}$ need not be zero inside the cavity.

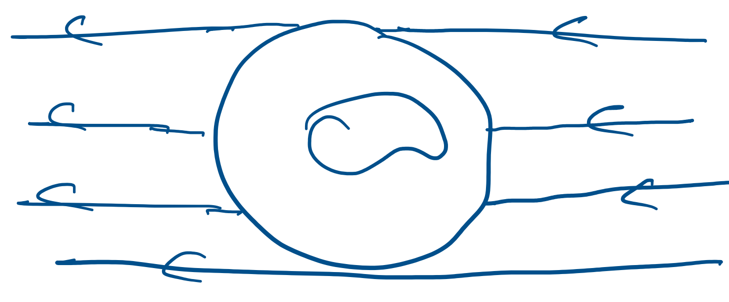
If charge inside a cavity is zero,



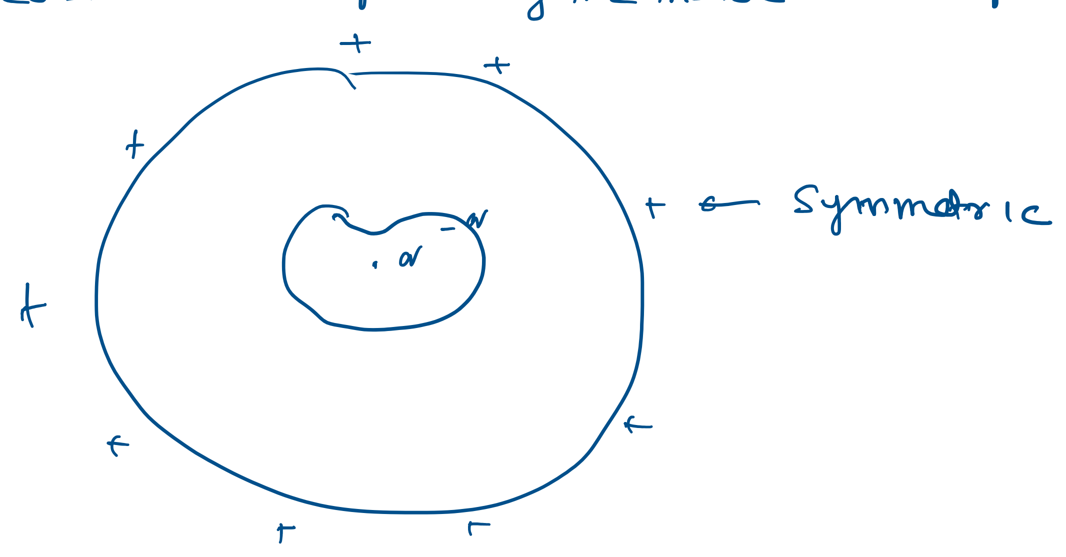
$\int E \cdot ds = 0$

Only if E is zero

also

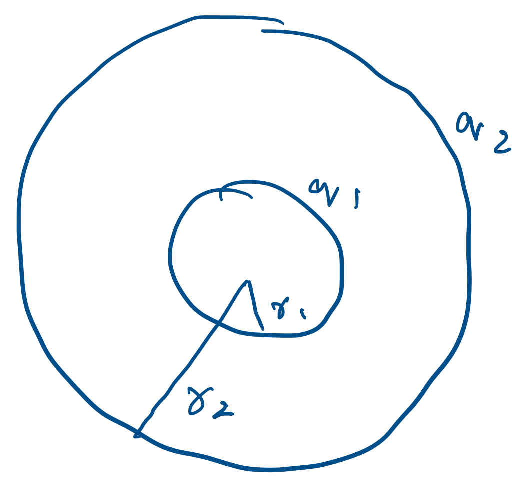


If there is a charge q in the cavity, a total charge $-q$ will redistribute itself along the inside wall of the cavity.



Grounding

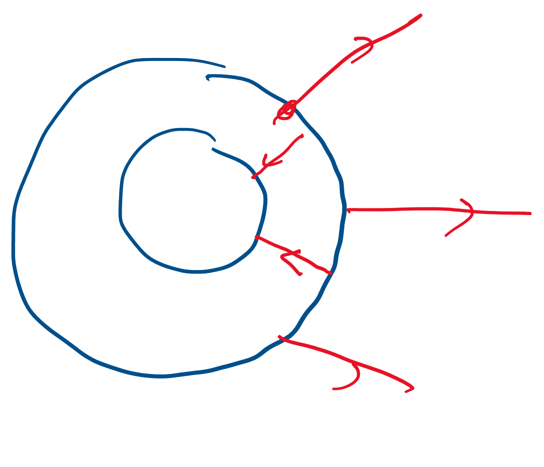
Setting a potential to zero by connecting a infinite reservoir.



Find
i) Potential everywhere
ii) What happens if we ground inside shell?
iii) What happens if we ground outer shell?

i) $V = \begin{cases} \dfrac{k(q_1+q_2)}{r}, & r > r_1, r_2 \\ \dfrac{kq_1}{r} + \dfrac{kq_2}{r_2}, & r_1 < r < r_2 \\ \dfrac{kq_1}{r_1} + \dfrac{kq_2}{r_2}, & r < r_1, r_2 \end{cases}$

ii) $\dfrac{kq_1}{r_1} + \dfrac{kq_2}{r_2} = 0$



$\Rightarrow q_1 = -\dfrac{q_2 r_1}{r_2}$

iii) $\dfrac{kq_1}{r_2} + \dfrac{kq_2}{r_2} = 0$

$\Rightarrow q_2 = -q_1$

I shall include image charges portion in Lecture 15 notes.