

Physics 102

Lecture 4.

Wed. Sept. 15, 2004.

- Electric field in a parallel-plate capacitor

uniform charge distribution.

Constant \vec{E} field inside.

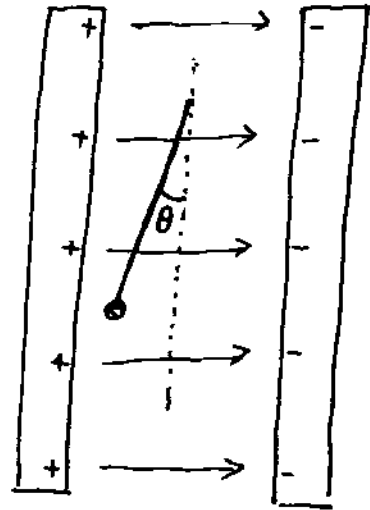
e.g. 19-6. (p. 629).

given: $\theta = 10.5^\circ$

$m = 0.025 \text{ kg}$

charge $-q = -3.10 \mu\text{C}$. ($Q = -q$)

($q > 0$)



Find: T , E .

electric field: \vec{E}

(electric force on Q : $Q\vec{E}$)

electric force on $-q$: $-q\vec{E}$.

static equilibrium:

$$\sum \vec{F}_i = 0$$

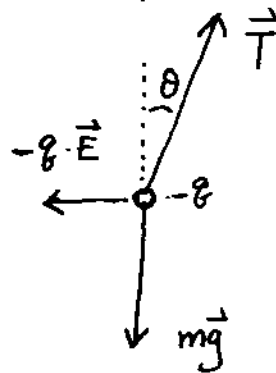
$$x: T \sin \theta - qE = 0 \quad (1)$$

$$y: T \cos \theta - mg = 0 \quad (2)$$

$$(2): T = \frac{mg}{\cos \theta} = 0.249 \text{ N}$$

$$(1): E = \frac{T \sin \theta}{q} = 1.46 \times 10^4 \text{ N/C}$$

Free Body Diagram:



Note: If we use Q to denote the charge.

Then, $Q = -3.10 \mu\text{C} < 0$.

electric force. $\vec{F} = Q\vec{E}$

$$\sum \vec{F}_i = 0:$$

$$x: T \sin \theta - |QE| = 0$$

$$\text{i.e.: } T \sin \theta + QE = 0$$

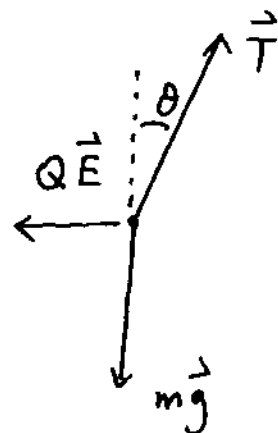
$$\left\{ \begin{array}{l} \because Q < 0 \\ |Q| = -Q \end{array} \right.$$

$$T \cos \theta - mg = 0$$

$$\therefore T = \frac{mg}{\cos \theta} = 0.249 \text{ N}$$

$$E = \frac{T \sin \theta}{-Q} = \frac{0.249 \text{ N} \times \sin 10.5^\circ}{-(-3.10 \mu\text{C})} = 1.46 \times 10^4 \text{ N/C}$$

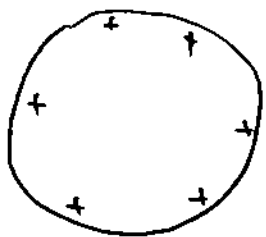
(Same as before).



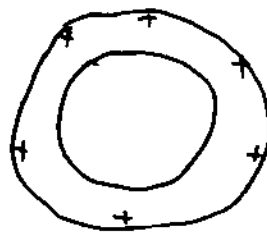
• Excess charge on a conductor

— Moves to the exterior surface.

Solid metal sphere



Hollow Metal sphere



Why? — if not, the charges will move outward.

repell!



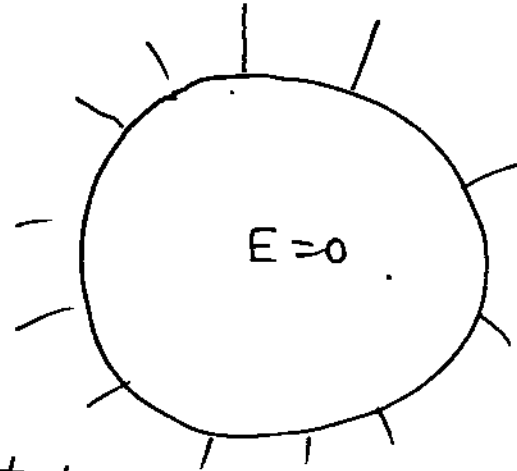
- Electrostatic shielding.

When charges are at rest, the electric field within a conductor is zero.

Why?

If $E \neq 0$, then the electrons will move.

↑ Not at rest!

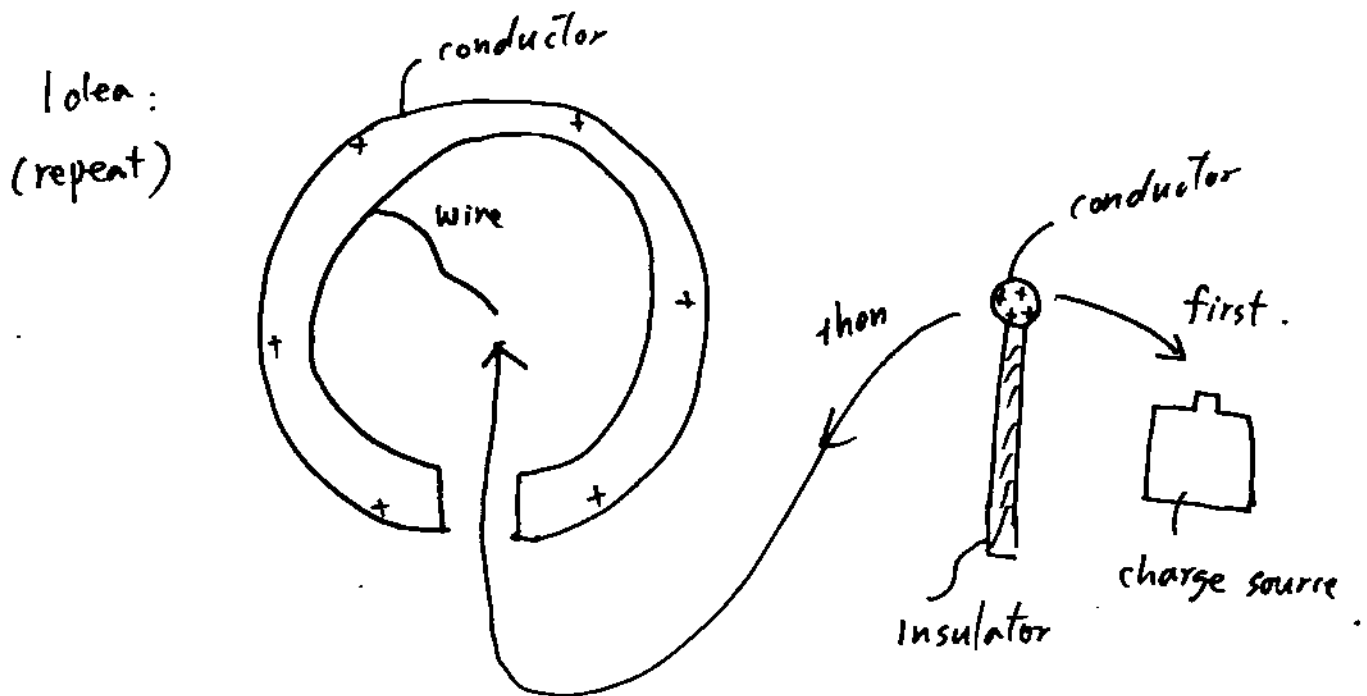


- Electric field at conductor surfaces:

$\vec{E} \perp$ surface. (if charges are at rest)

{ otherwise, electrons will move along the surface.
 $\therefore \vec{E}$ would have a non-zero component along the surface }

- How to get more and more charge on a hollow sphere



- Van de Graaff generator

One can gain a large amount of charge on the sphere.

