

Lecture # 7

Electric Potentials

# Exam Schedule

Friday

6-8 pm

9/19, 10/17, 11/14, 12/15

Room

BUR 106

A sheet has a uniform charge density  $\sigma$ . What is the magnitude of the electric field on the

(a) right side of the sheet, ~~(b)~~

(b) left side of the sheet

(a)

1.  $\frac{\sigma}{\epsilon_0}$

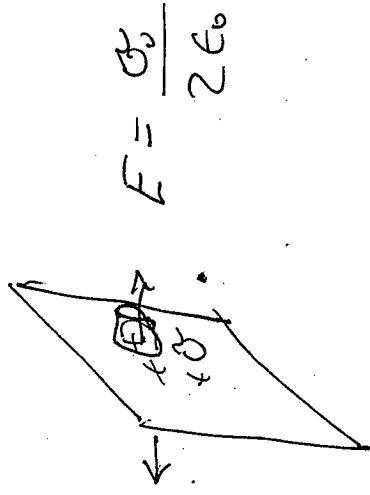
(b)  $\frac{\sigma}{2\epsilon_0}$

2.  $\frac{\sigma}{2\epsilon_0}$

3.  $\frac{\sigma}{\epsilon_0}$

4.  $\frac{\sigma}{2\epsilon_0}$

5.  $\frac{\sigma}{2\epsilon_0}$





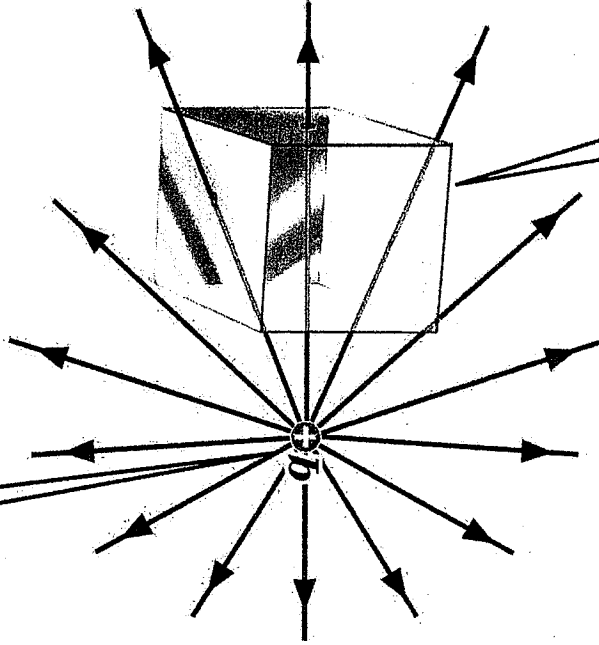
## Checkup 24.1

Consider the point charge and surface of the figure above. The net flux through this

surface is

- a. Positive
- b. Negative
- c. Zero

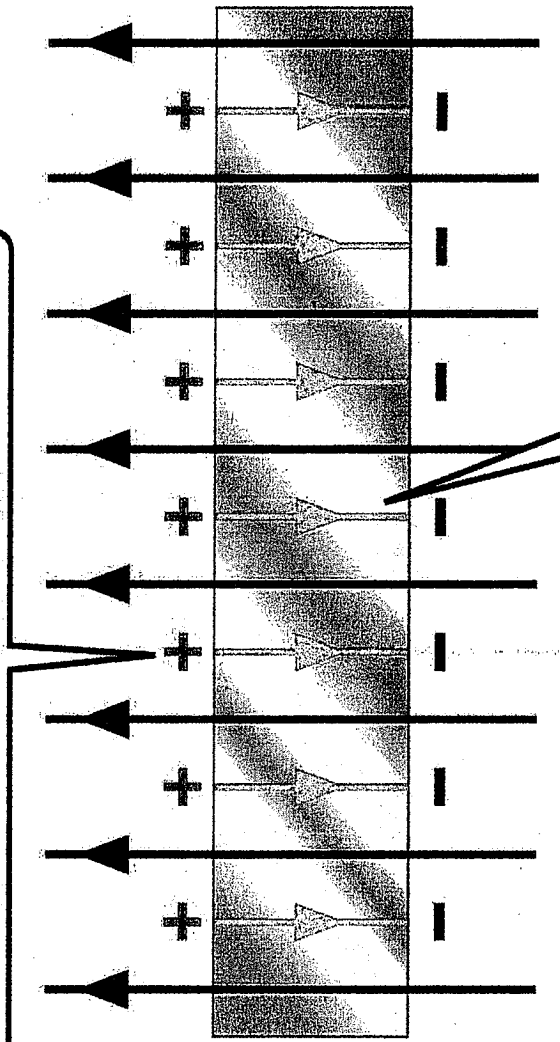
With a point charge outside a cube...



...what is the net flux through the cube?

We place a conductor sheet inside a uniform electric field. How can the electric field vanish inside conductor?

**Charge accumulates on surfaces of conductors in response to external fields.**



**In equilibrium, electric field of induced charges exactly cancels external field.**

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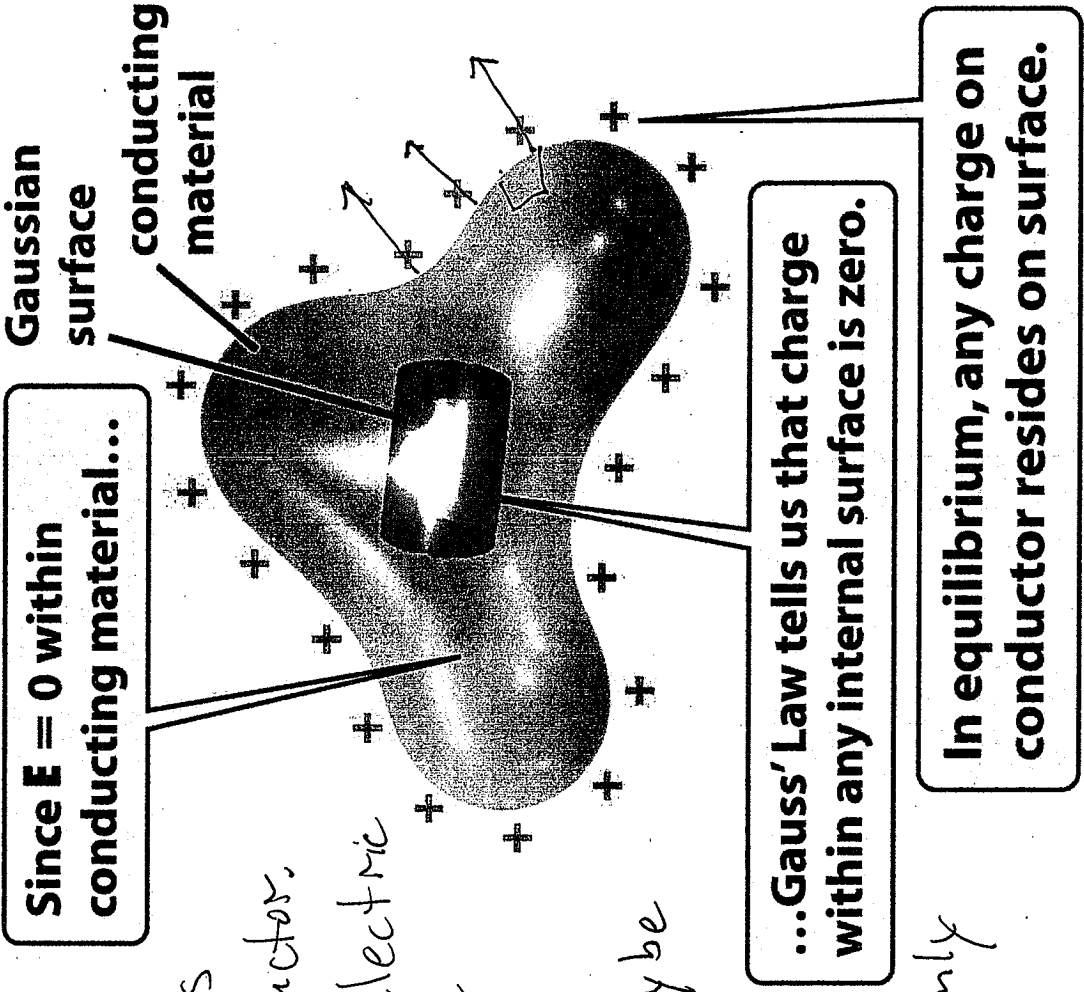


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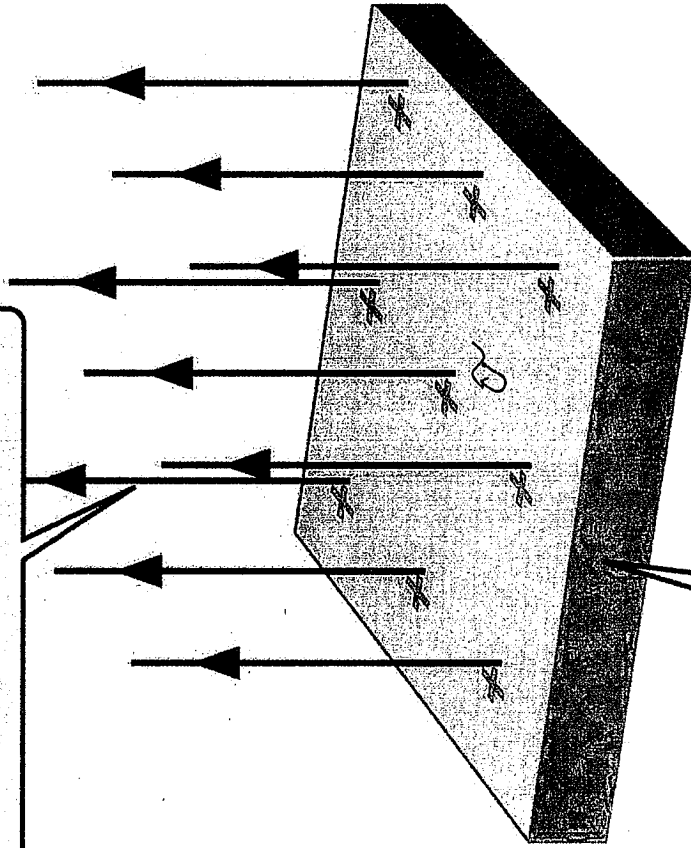
Charge is on this conductor.

Is there electric field in the conductor?

yes, no, maybe

Is the charge uniformly distributed on surface of conductor for the material shape shown? no!

**Outside,  $E$  is  
perpendicularly  
outward from surface...**



**...and inside conductor,  
we know  $E = 0$ .**

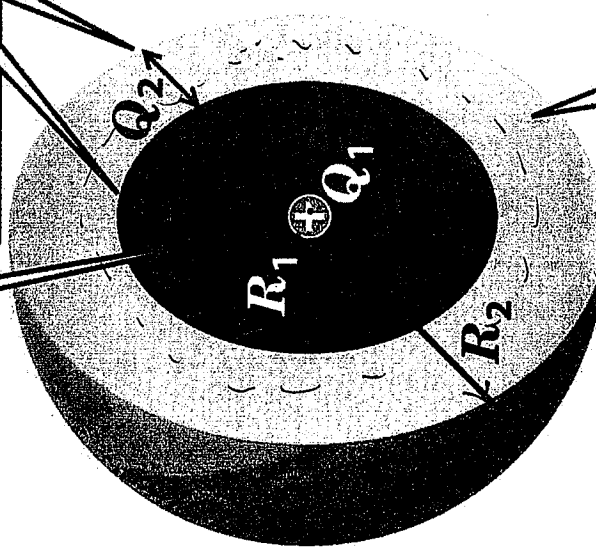
$$E = \frac{\sigma_0}{\epsilon_0}$$

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Point charge  $Q_1$  is at center of spherical shell cavity.

Conducting shell has net charge  $Q_2$  on its surfaces.

$R_1$  is inner radius } of  
 $R_2$  is outer radius } shell  
 How is charge distributed in this conductor?



We know  $E = 0$  inside a conductor.

$$Q_2' = Q_2 + Q_1$$

$$Q_2' = \frac{Q_2 + Q_1}{4\pi R_2^2}$$

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charge on inside surface?  $-Q_1, \sigma_1 = \frac{-Q}{4\pi R_1^2}$



How are electric field and local surface charge density related at the surface of a conductor?

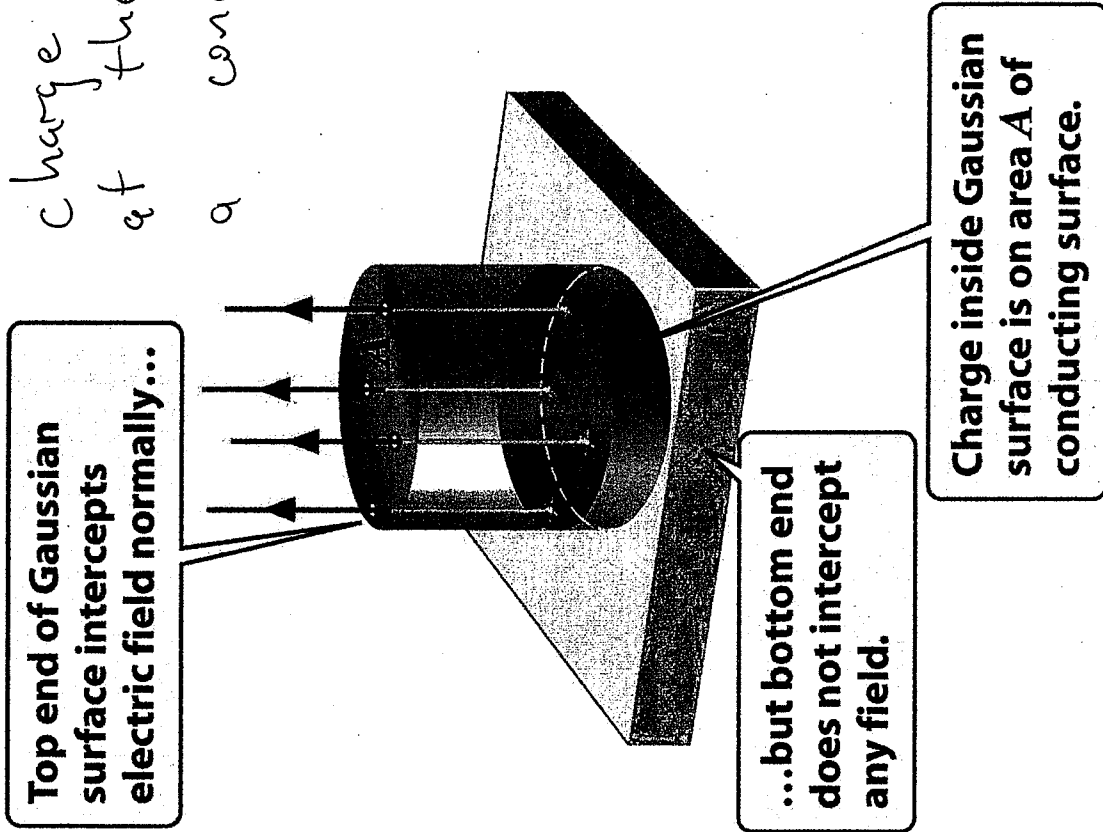


Figure 24-23b Physics for Engineers and Scientists 3/e  
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## GAUSS' LAW

$$\Phi_E = \oint E_{\perp} dA = \frac{Q_{\text{inside}}}{\epsilon_0}$$

$$\oint E_{\perp} dA = \begin{cases} E \times 4\pi r^2 & \text{(spherical)} \\ E \times 2\pi rL & \text{(cylindrical)} \\ 2EA & \text{(planar, both ends in field)} \\ EA & \text{(planar, one end in field)} \end{cases}$$

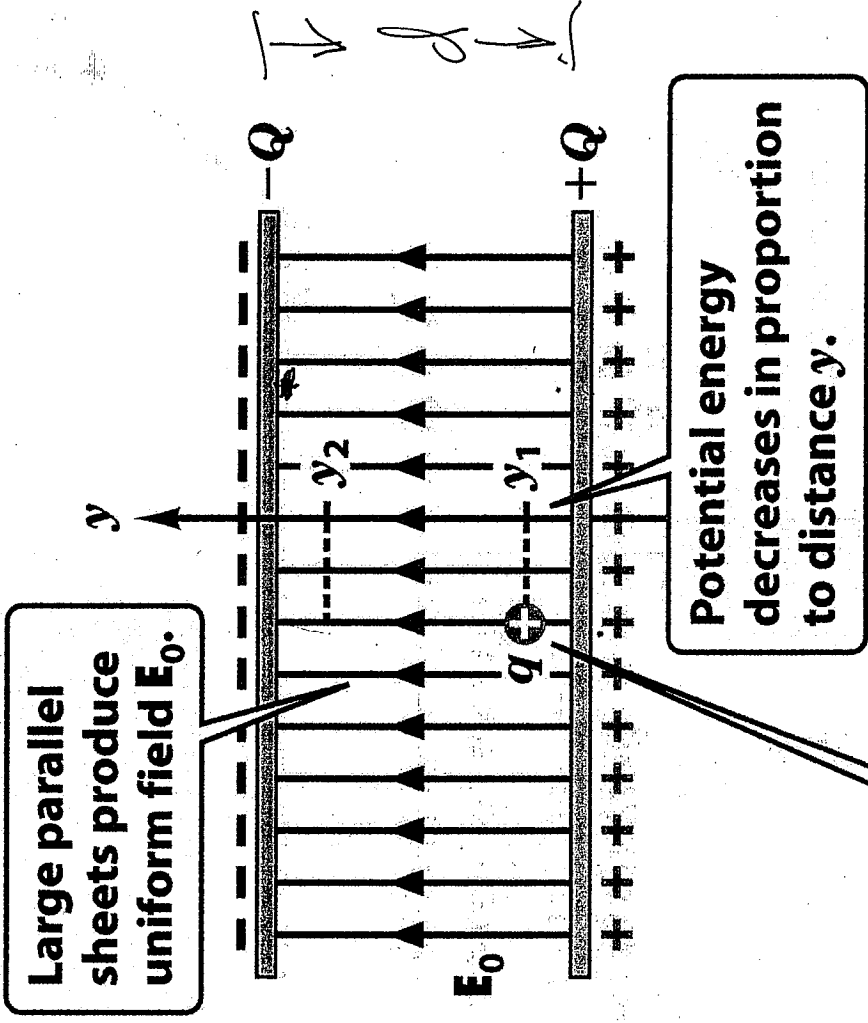
(for a finite thickness conductor, where one end of pillbox is in conductor)

## UNIFORM CHARGE DISTRIBUTIONS

$$q = \lambda L$$

$$q = \sigma A$$

$$q = \rho V$$



To slowly push positive charge  $q$  from negative to positive plate requires external work  $W = qE_0d$

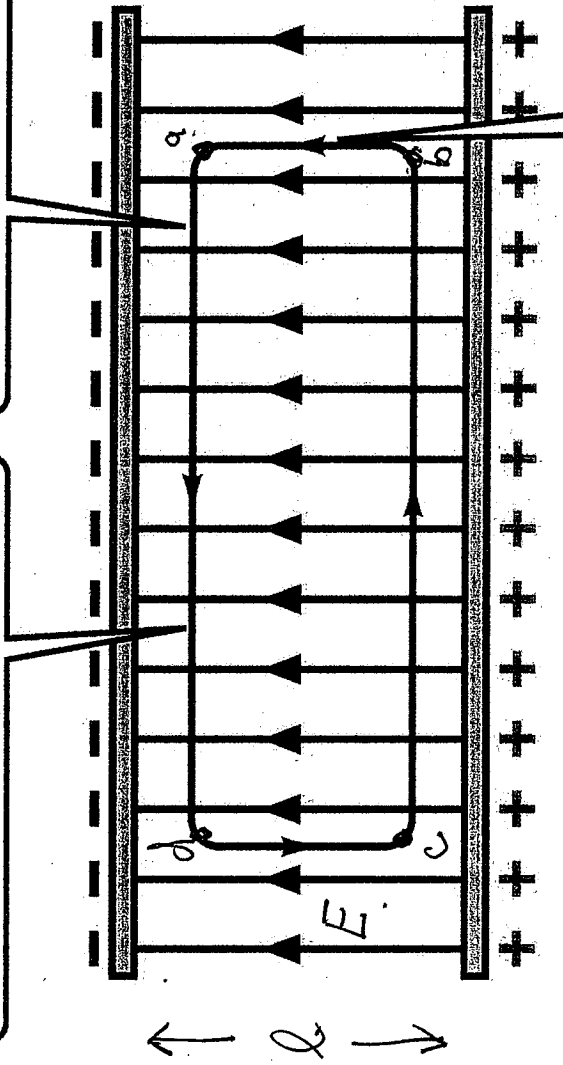
$$PE = qE_0d = qV$$

$$\text{Potential} = \frac{PE}{q} = E_0d = V$$

$V \equiv \text{Voltage}$  "

We consider the work done as a charge moves around an imagined path.

Electric field is perpendicular to horizontal segments.



Electric field is parallel to one vertical segment, antiparallel to the other.

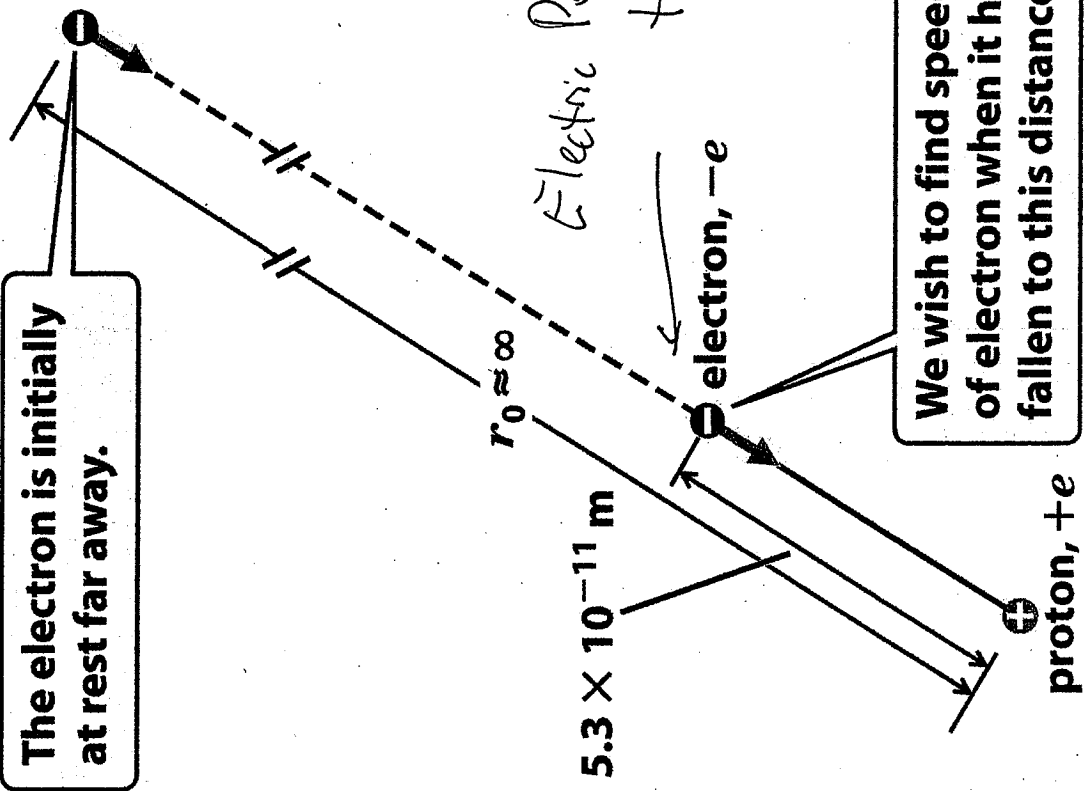
How much work does it take to move a positive charge from a to b?  $(qEL)$

Is this work dependent on path?

How much work does it take to move along a-b-c-d-e? Does the answer change if we move a charge -q?

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The electron is initially at rest far away.



Energy is conserved

Electric Potential due to this electron

$$V = \frac{-k|e|}{4\pi\epsilon_0 r}$$

We wish to find speed of electron when it has fallen to this distance.

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