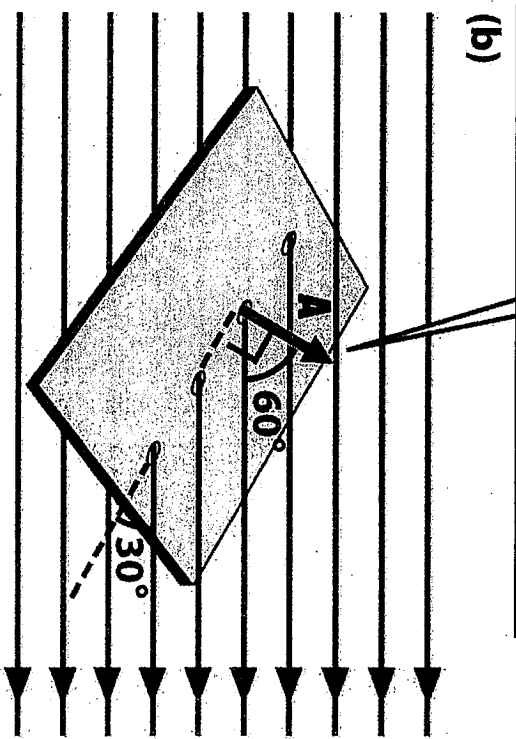
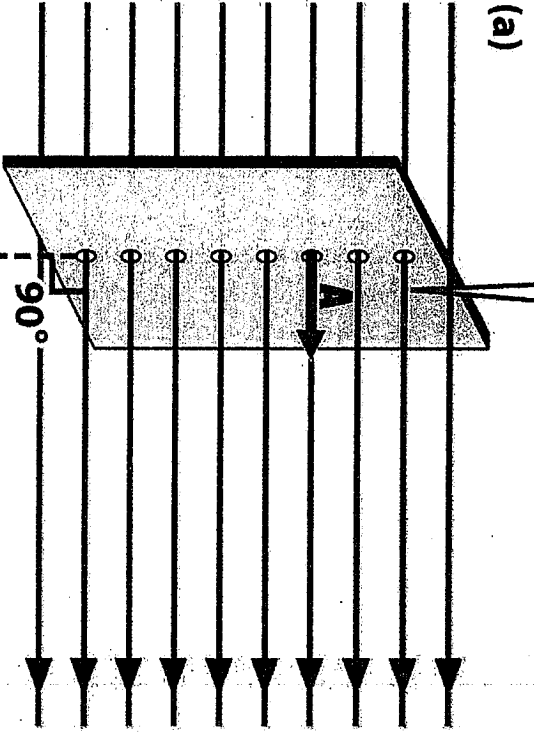
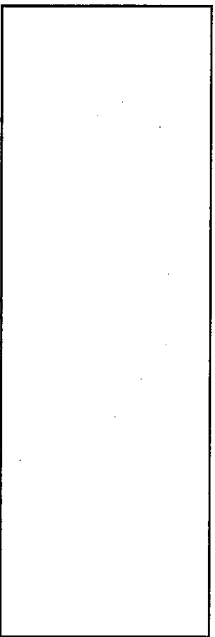
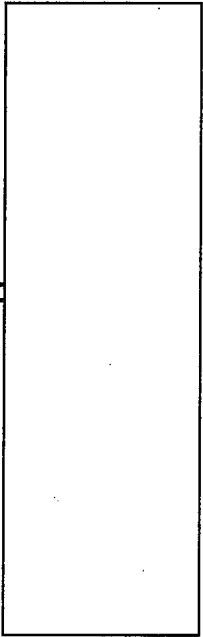


Lecture  
# 6

Gauss' Law

What is the electric flux through (a) and (b) in and electric field E?



1. 0 and EA respectively
2. EA and EA/2 ✓
3. EA and  $\sqrt{3}EA/2$
4. 0 and EA/2
5. 0 and  $\sqrt{3}EA/2$

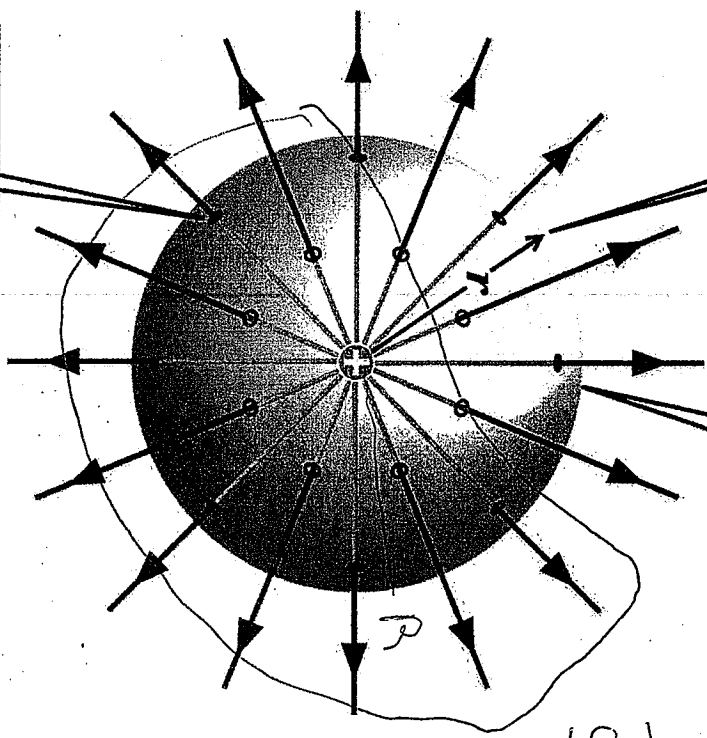
$$\cos 60^\circ = \frac{1}{2}$$

Figure 24-5 Physics for Engineers and Scientists 3/e  
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Point Ch  
in Cent of  
sphere

Consider an imaginary spherical surface with radius  $r$ .

Electric field is everywhere perpendicular to surface.



Magnitude of electric field is constant over area  $4\pi r^2$ .

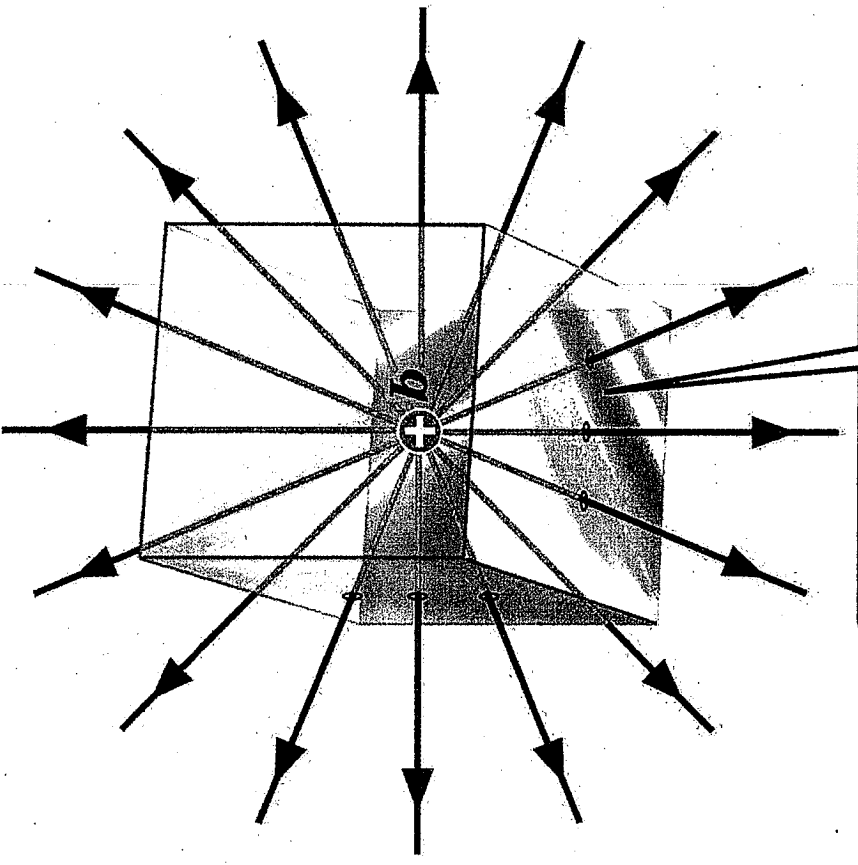
Figure 24-6 Physics for Engineers and Scientists 3/e © 2007 W.W.Norton & Company, Inc.

$$\Phi_E = E(n) A$$

$$= \frac{Q}{4\pi\epsilon_0 r^2} \cdot 4\pi r^2$$

$$\Phi_E = \frac{Q}{\epsilon_0}$$

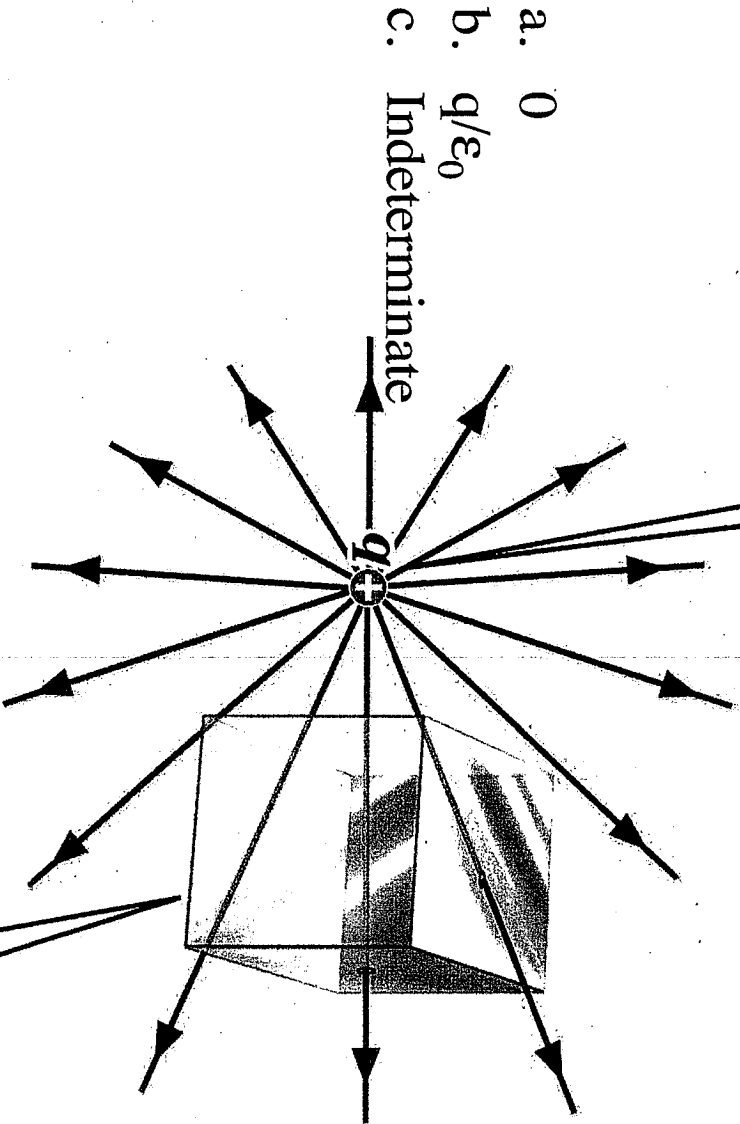
**The sphere of Example 2 has been replaced by a cube. Does the flux change?**



$$\Phi_E = \frac{Q}{\epsilon_0}$$

Figure 24-8 Physics for Engineers and Scientists 3/e  
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**With a point charge outside a cube...**

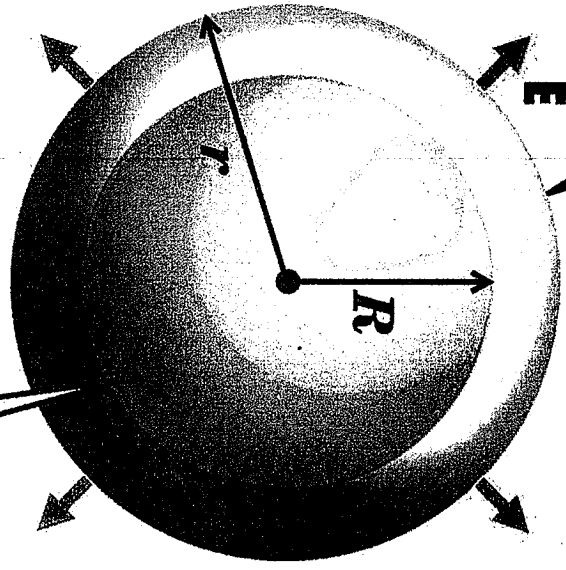


- a. 0
- b.  $q/\epsilon_0$
- c. Indeterminate

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

Figure 24-9 Physics for Engineers and Scientists 3/e  
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Imagine a surface with  $r > R$ , where you want to know the value of  $E$ .



Now the charge inside our Gaussian surface is all of the charge on the sphere.

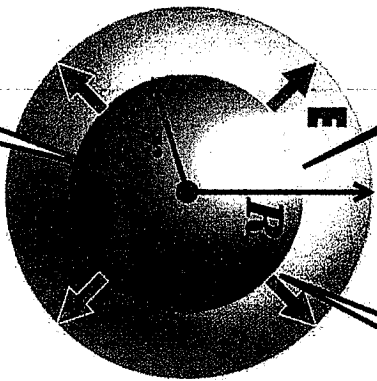
Just like a point charge

$$E_r = \frac{Q}{4\pi\epsilon_0 r^2}$$

Figure 24-12b Physics for Engineers and Scientists 3/e © 2007 W. W. Norton & Company, Inc.

To apply Gauss' Law, imagine a spherical surface with radius  $r < R$ , where you want to know the value of  $E$ .

Electric field is radial and perpendicular to surface of area  $4\pi r^2$ .



We then determine the amount of charge inside our imaginary surface,  $Q_{\text{inside}} = \rho V_{\text{inside}}$ .

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

Inside, the electric field increases in proportion to the distance from the center.

Outside a spherically symmetric charge distribution, the inverse-square electric field is the same as if all of the charge were concentrated at the center.

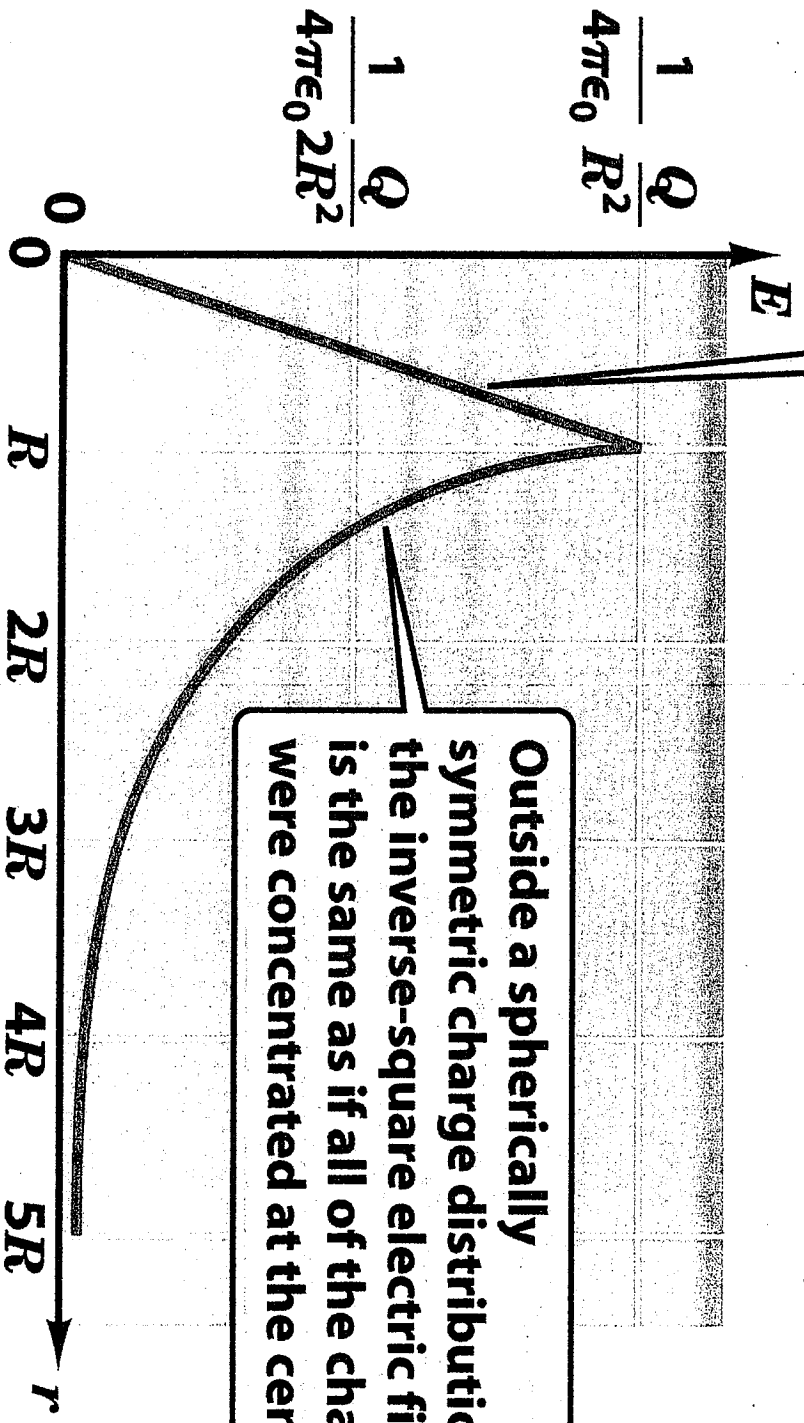


Figure 24-13 Physics for Engineers and Scientists 3/e  
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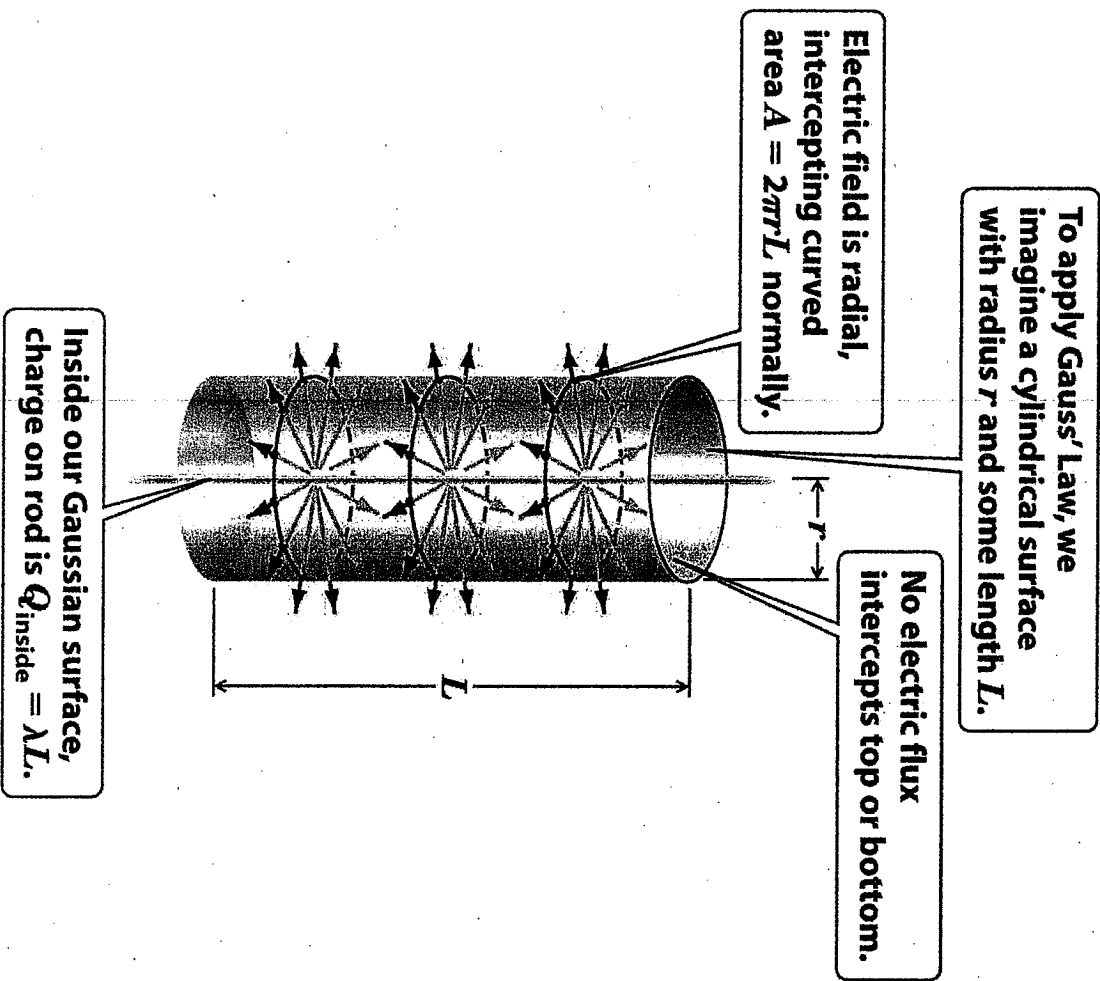
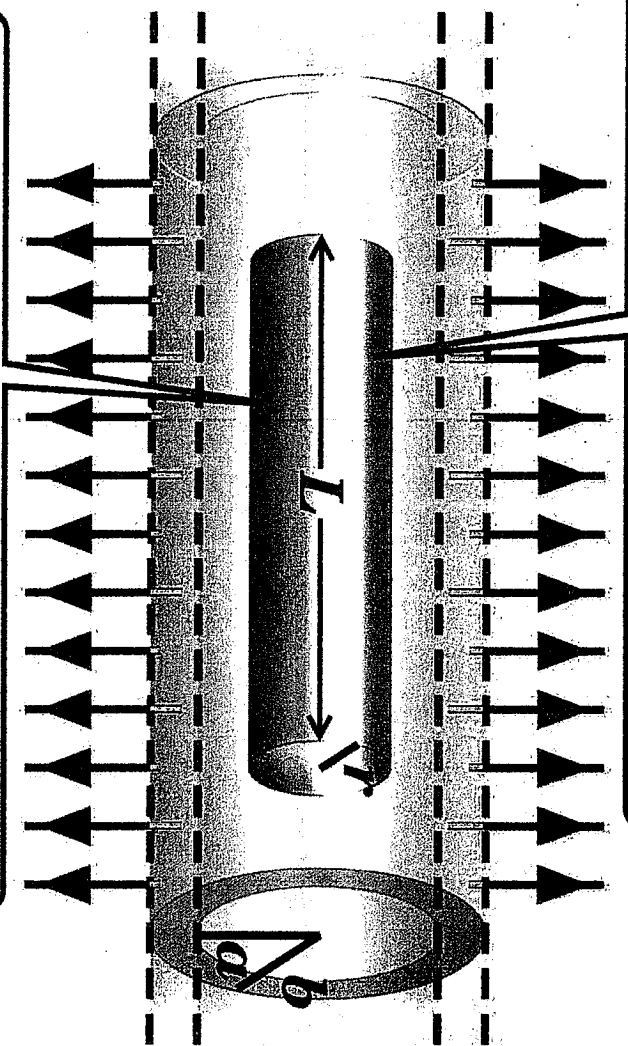


Figure 24-14 Physics for Engineers and Scientists 3/e  
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$$r \leq a$$

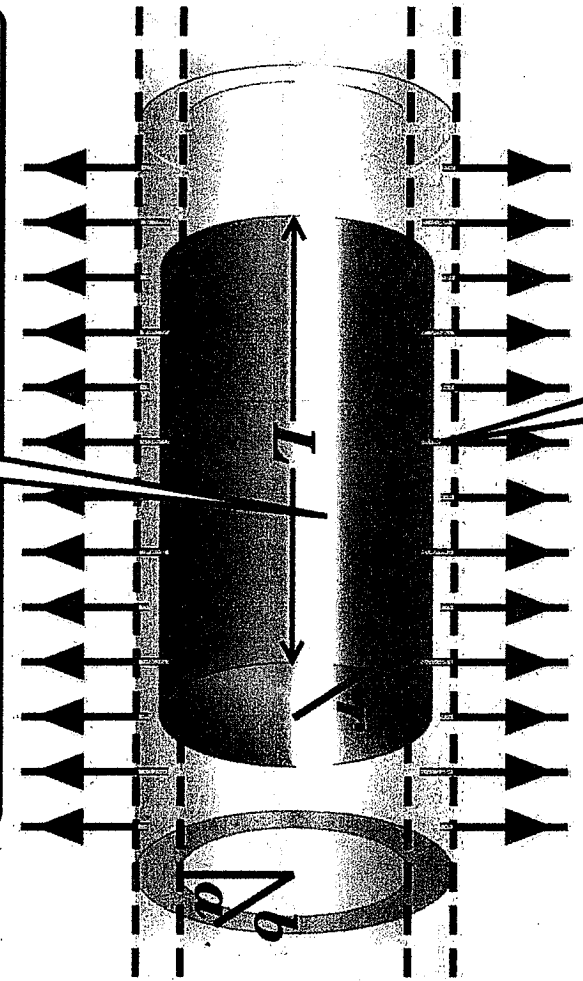
Gaussian surface is a cylinder of radius  $r$  and length  $L$ .



No charge resides in empty region inside Gaussian surface.

$$a \leq r \leq b$$

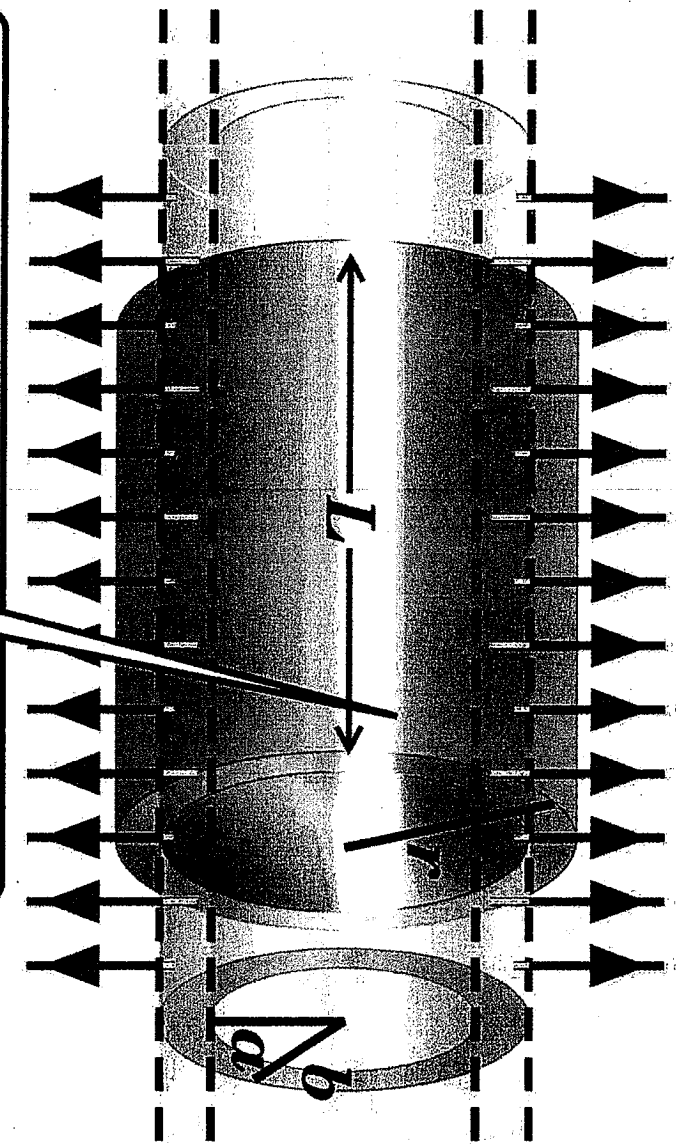
Radial flux intersects curved surface normally.



Charge inside this Gaussian surface occupies shell of outer radius  $r$  and inner radius  $a$ .

Figure 24-15b Physics for Engineers and Scientists 3/e  
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$$r \geq b$$



**Charge inside this Gaussian surface is entire charge on length  $L$  of shell.**

Figure 24-15c Physics for Engineers and Scientists 3/e  
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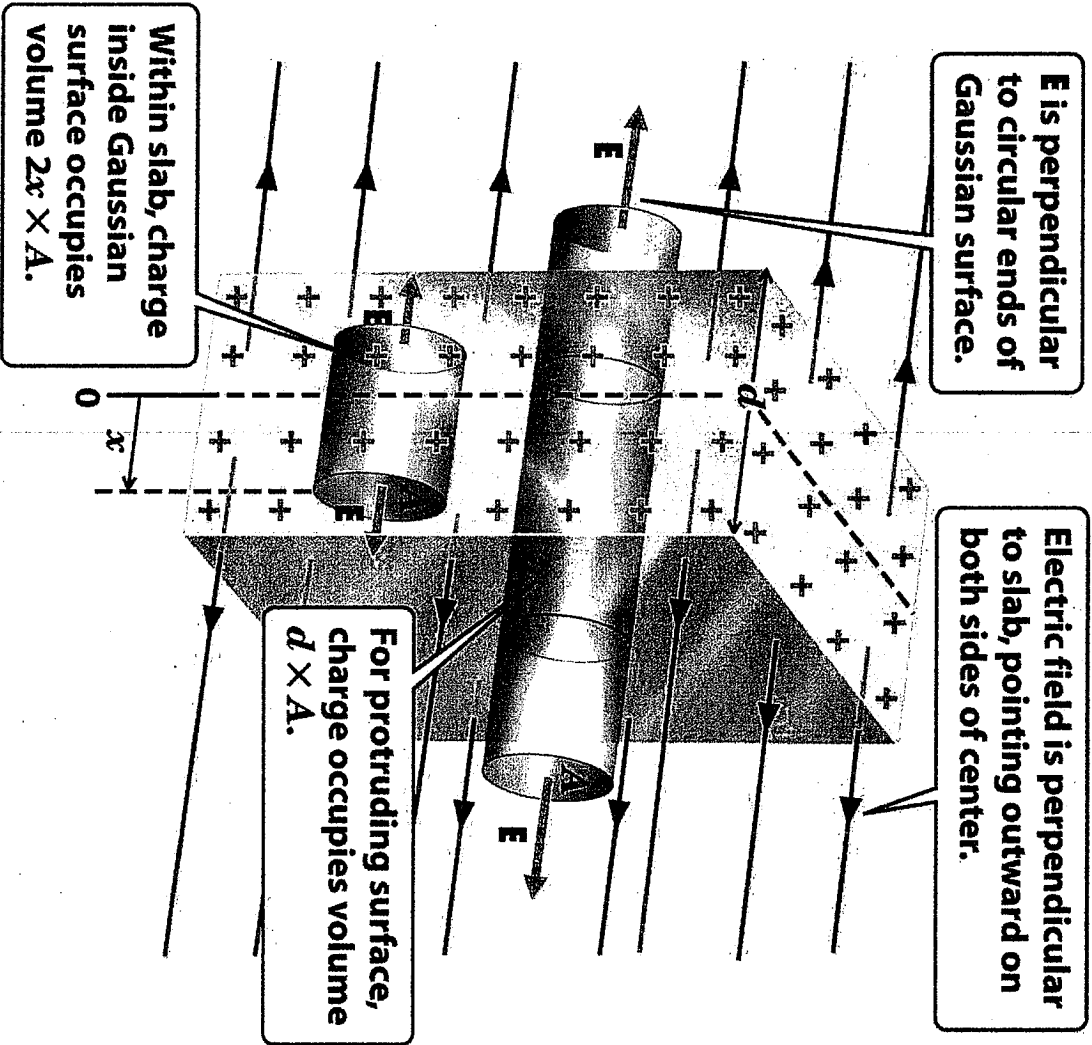
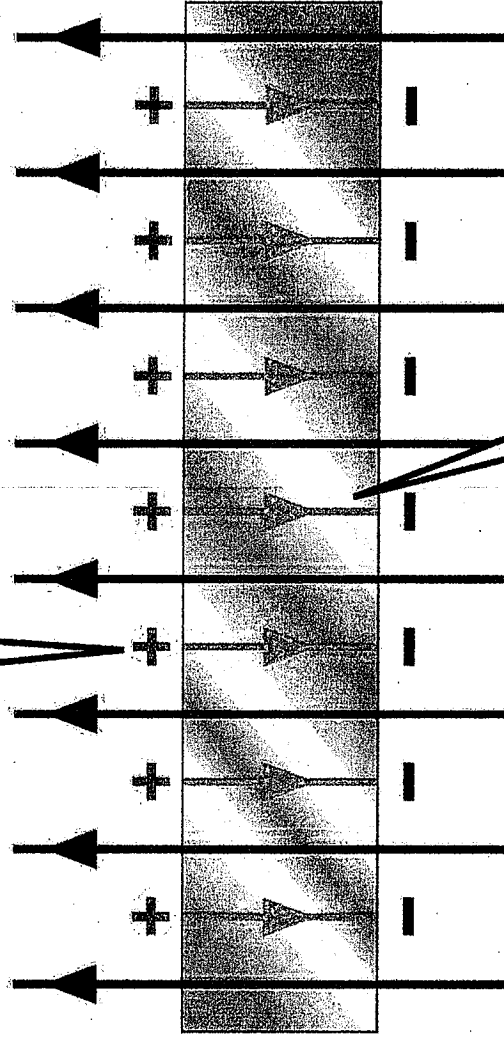


Figure 24-17 Physics for Engineers and Scientists 3/e  
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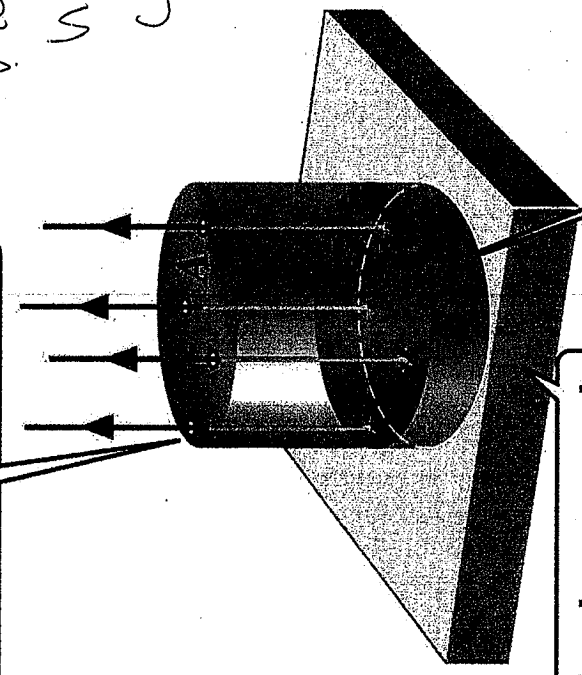
**Charge accumulates on surfaces of conductors in response to external fields.**



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

Figure 24-20 Physics for Engineers and Scientists 3/e  
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Top end of Gaussian surface intercepts electric field normally...



...but bottom end does not intercept any field.

Charge inside Gaussian surface is on area  $A$  of conducting surface.

$E$ - fields must be normal to conductor!

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

Figure 24-23b Physics for Engineers and Scientists 3/e © 2007 W. W. Norton & Company, Inc.

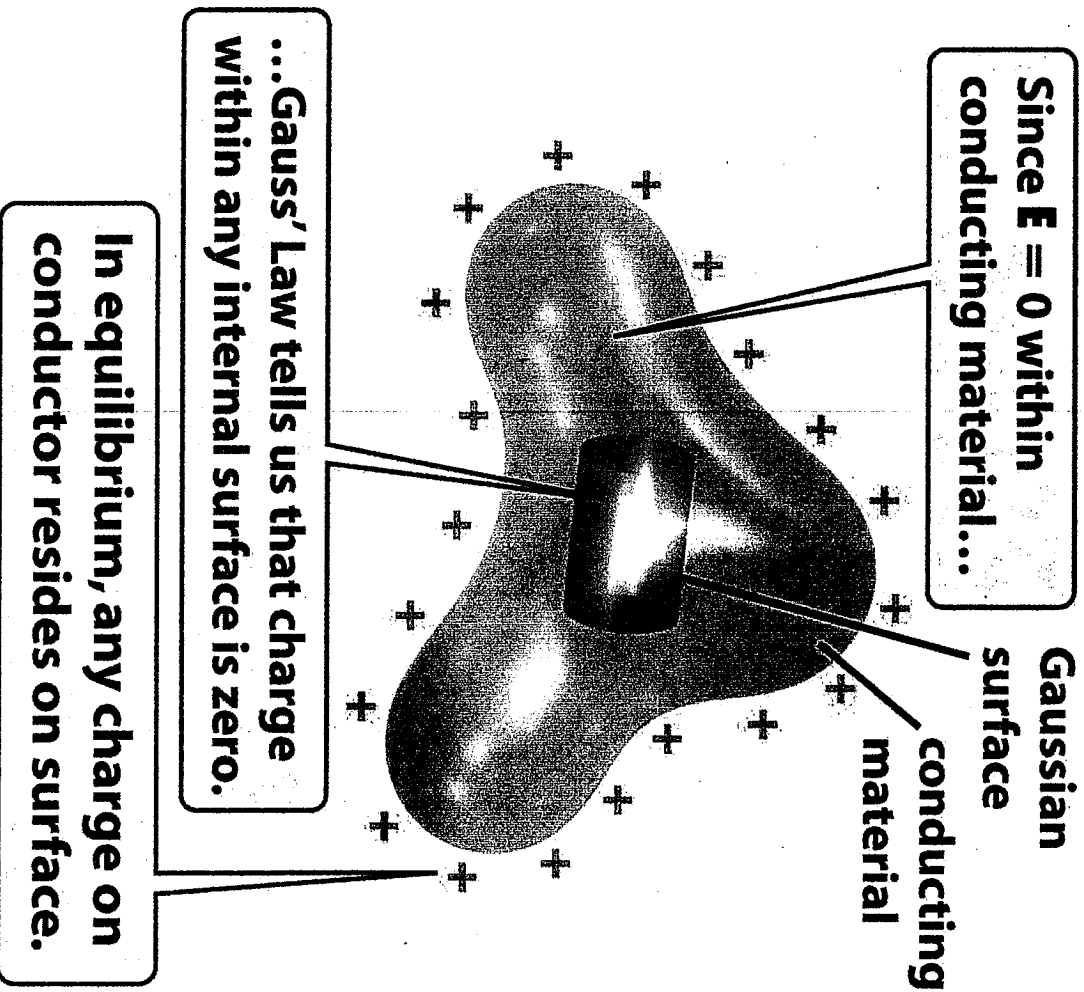


Figure 24-21 Physics for Engineers and Scientists 3/e  
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