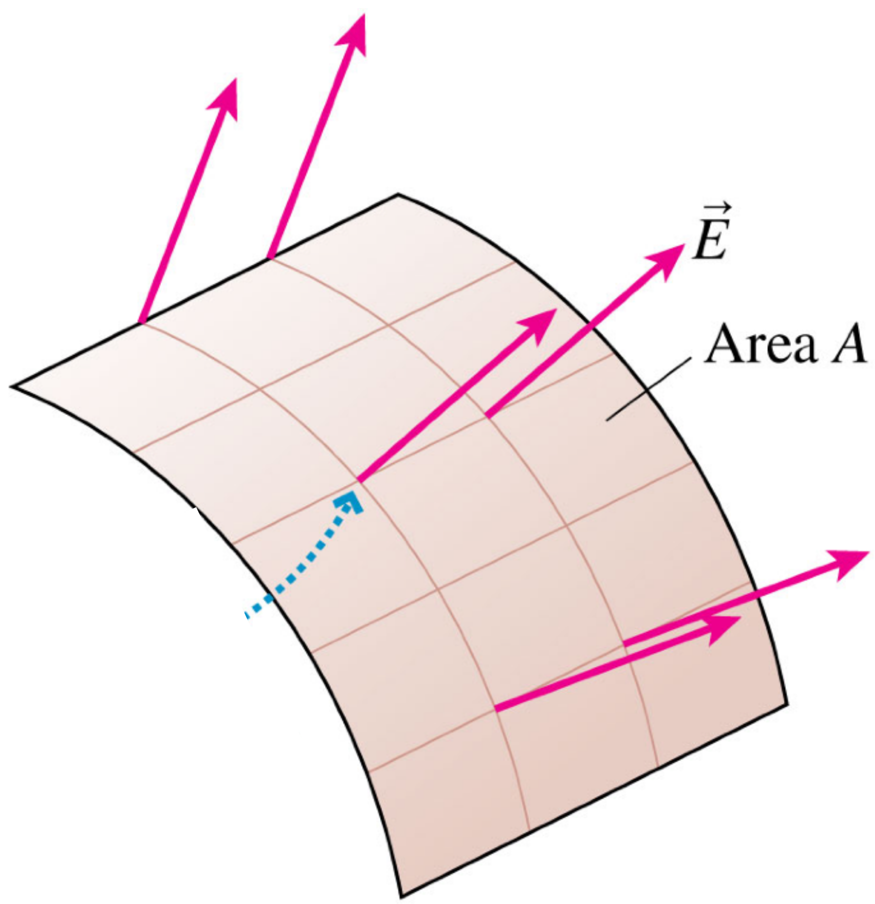
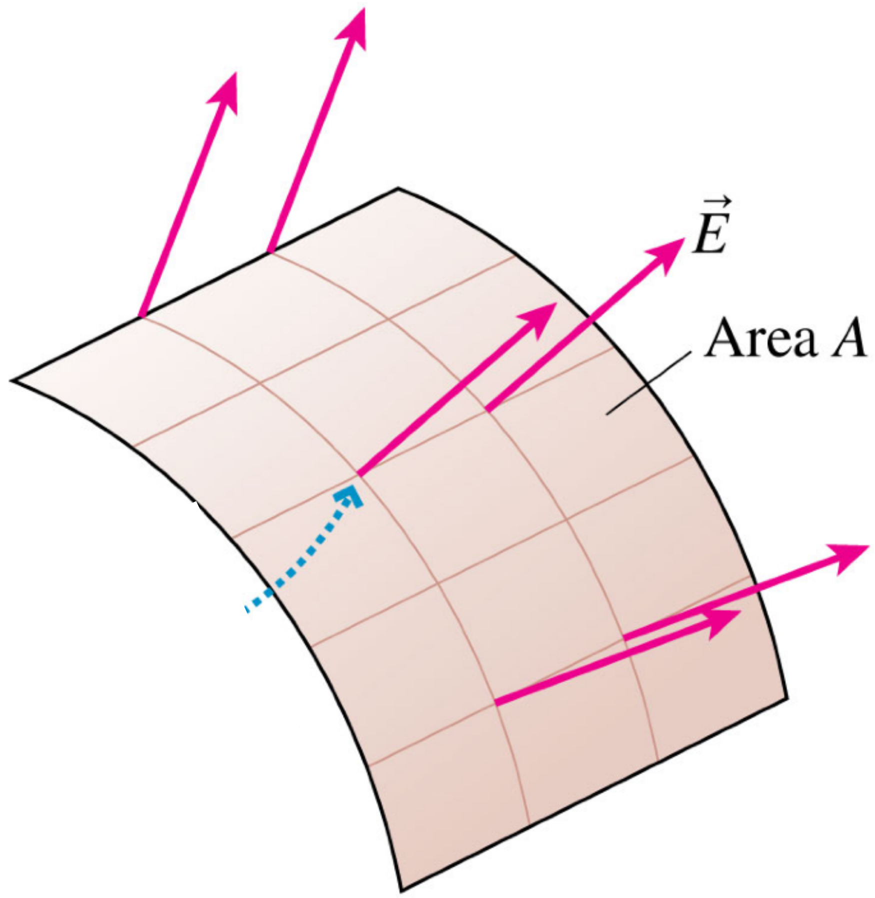
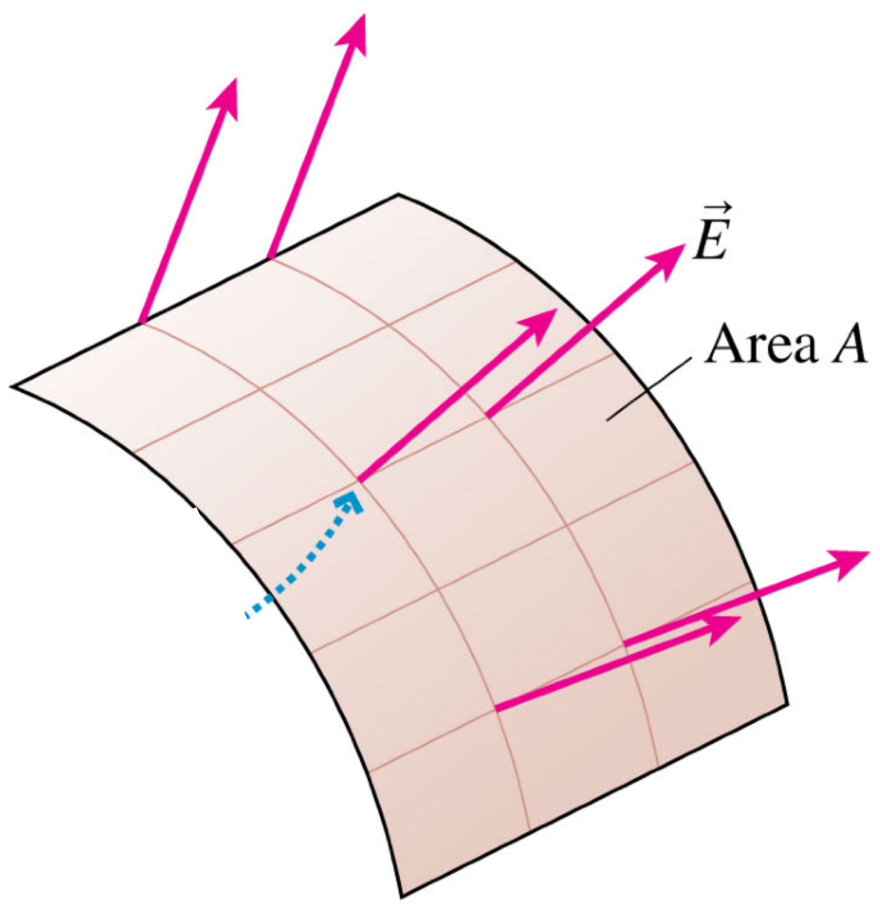

PH 220
Lance Nelson


$\vec{E}$
Area A



$$\Phi_e = \int_{\text{surface}} \vec{E} \cdot d\vec{A} = \int_{\text{surface}} E\, dA = E \int_{\text{surface}} dA = EA$$

$$\Phi = \int_{\text{surface}} \vec{E} \cdot \hat{N}\, dS$$



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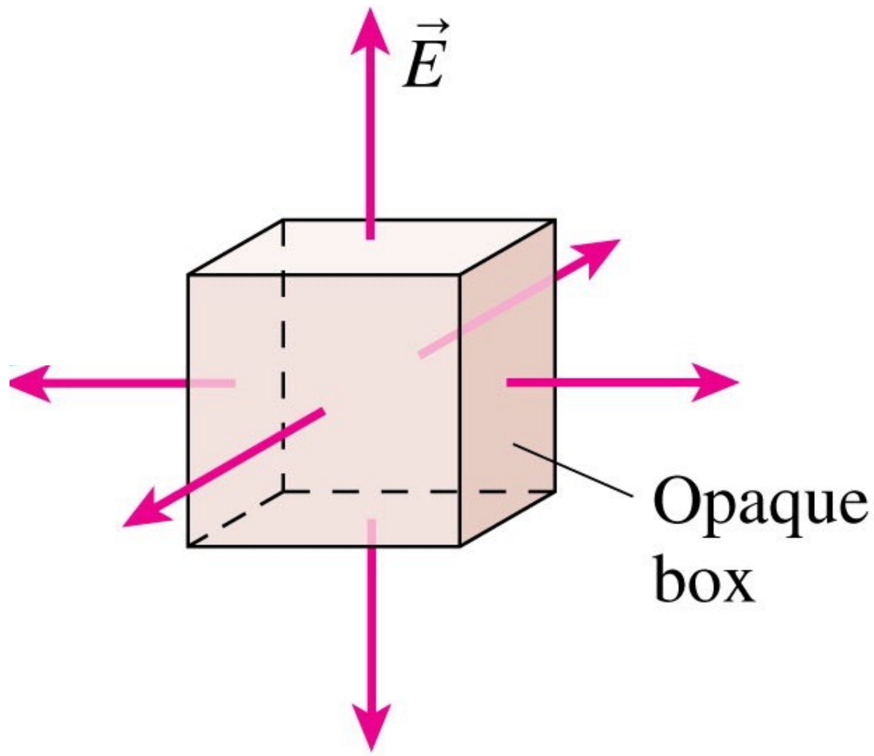
Why Flux? What does it even tell us?

Shown in the figure is an opaque box (can't see what's inside). Also shown are the electric field vectors on the box faces. What can you conclude about the contents of the box?

Question #28



c) There must be a negative charge inside the box.
d) There must be a positive charge inside the box.
e) There is no charge inside the box.

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Question #29

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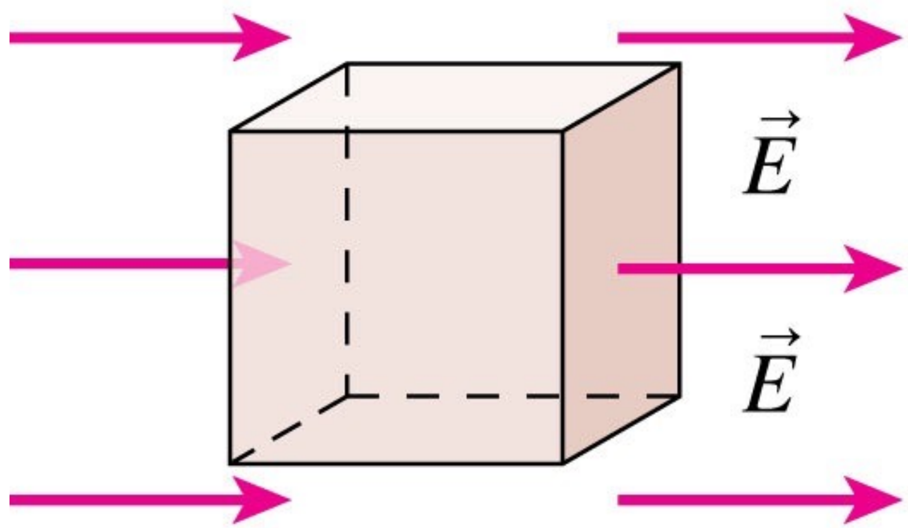

c) There must be a positive charge inside the box.
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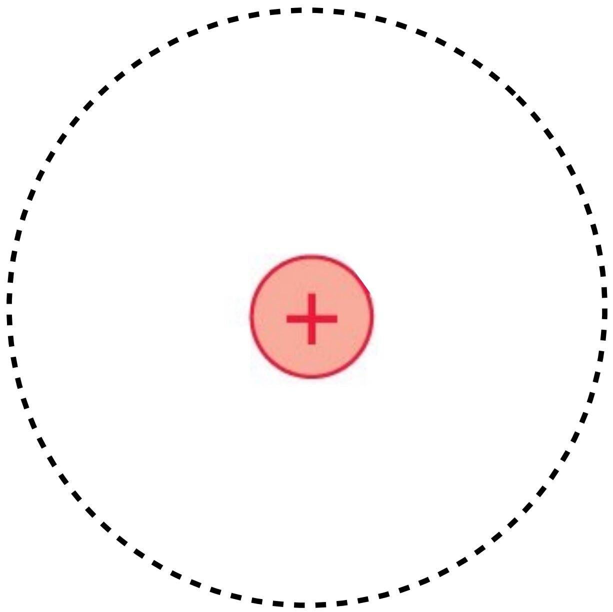
Answer the questions below to derive Gauss's Law



A. Draw several electric field lines at the gaussian surface.
B. Are the magnitudes of these electric field vectors the same or different.
C. Calculate the electric flux through this surface (do the integral).
D. Reduce your expression as far as you can.

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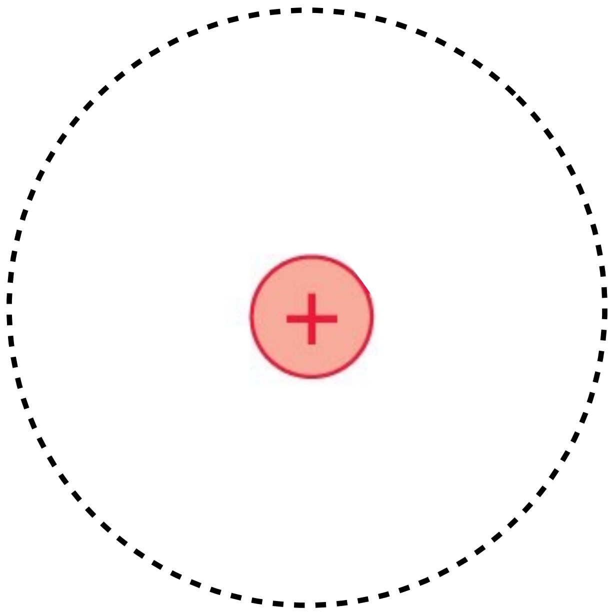

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Gauss's Law $$\oint \vec{E} \cdot d\vec{A} = \frac{q_{\text{in}}}{\epsilon_0}$$

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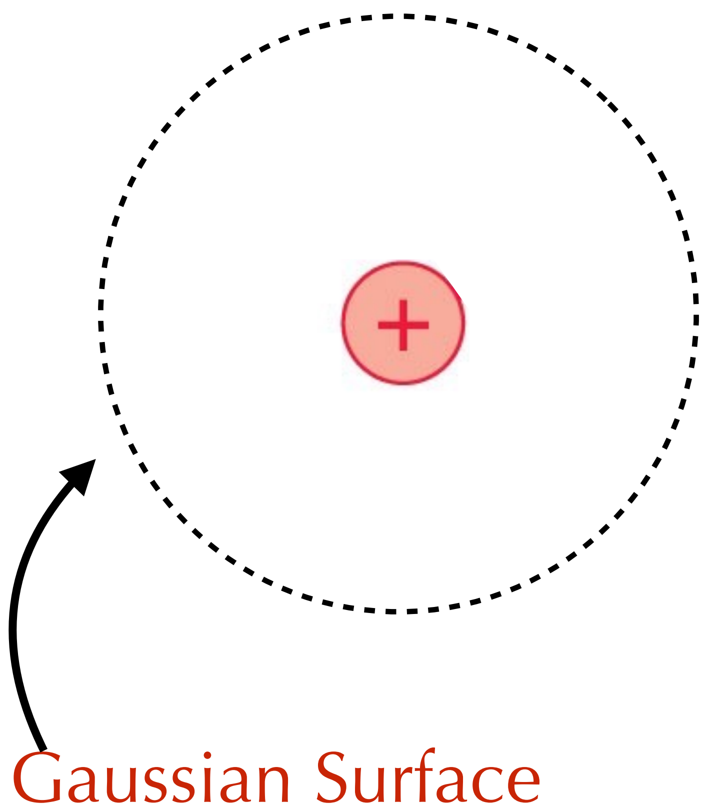

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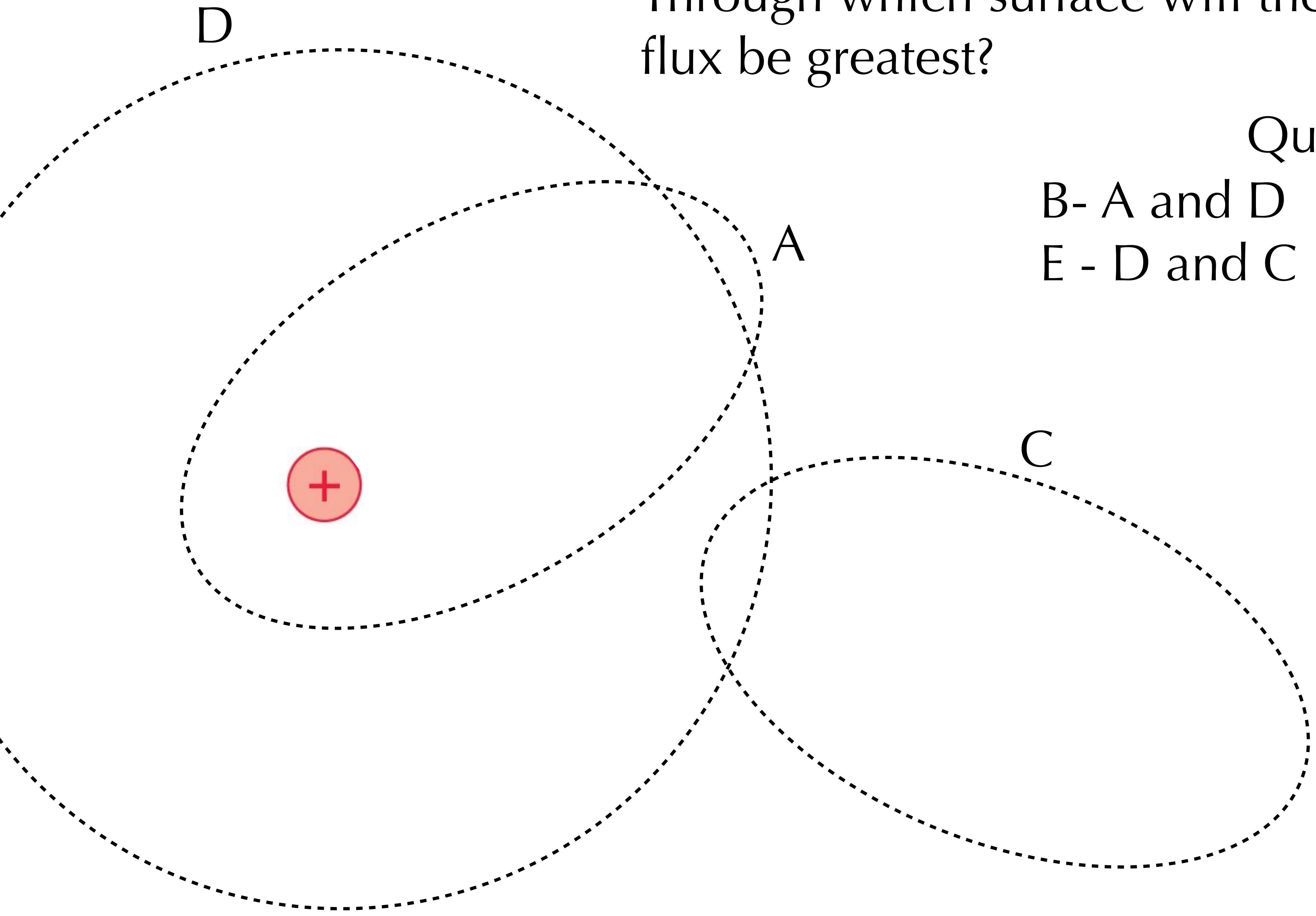
Through which surface will the electric flux be greatest?

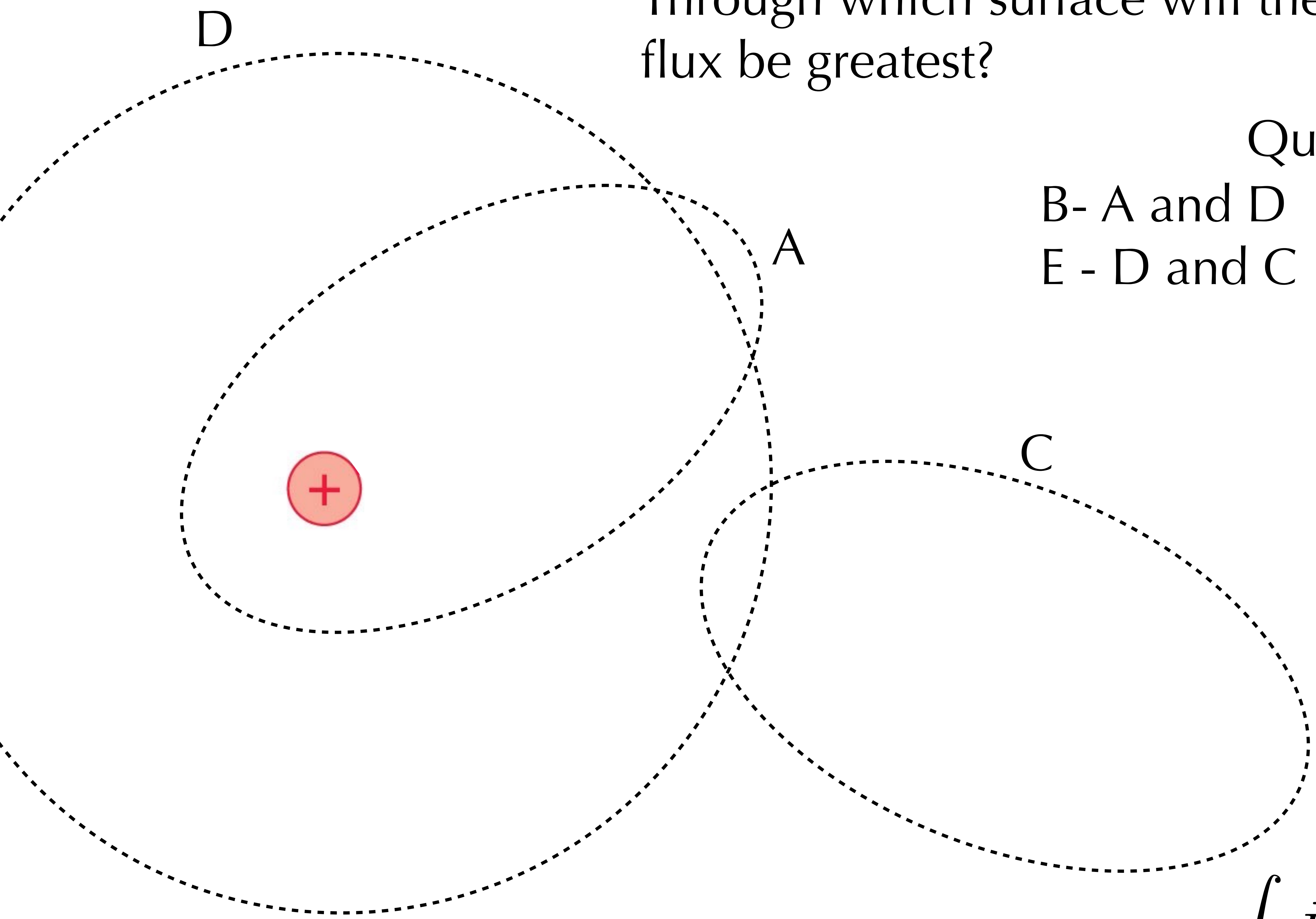
Question #30

B- A and D

E - D and C



Through which surface will the electric flux be greatest?



Question #30

B- A and D

E - D and C

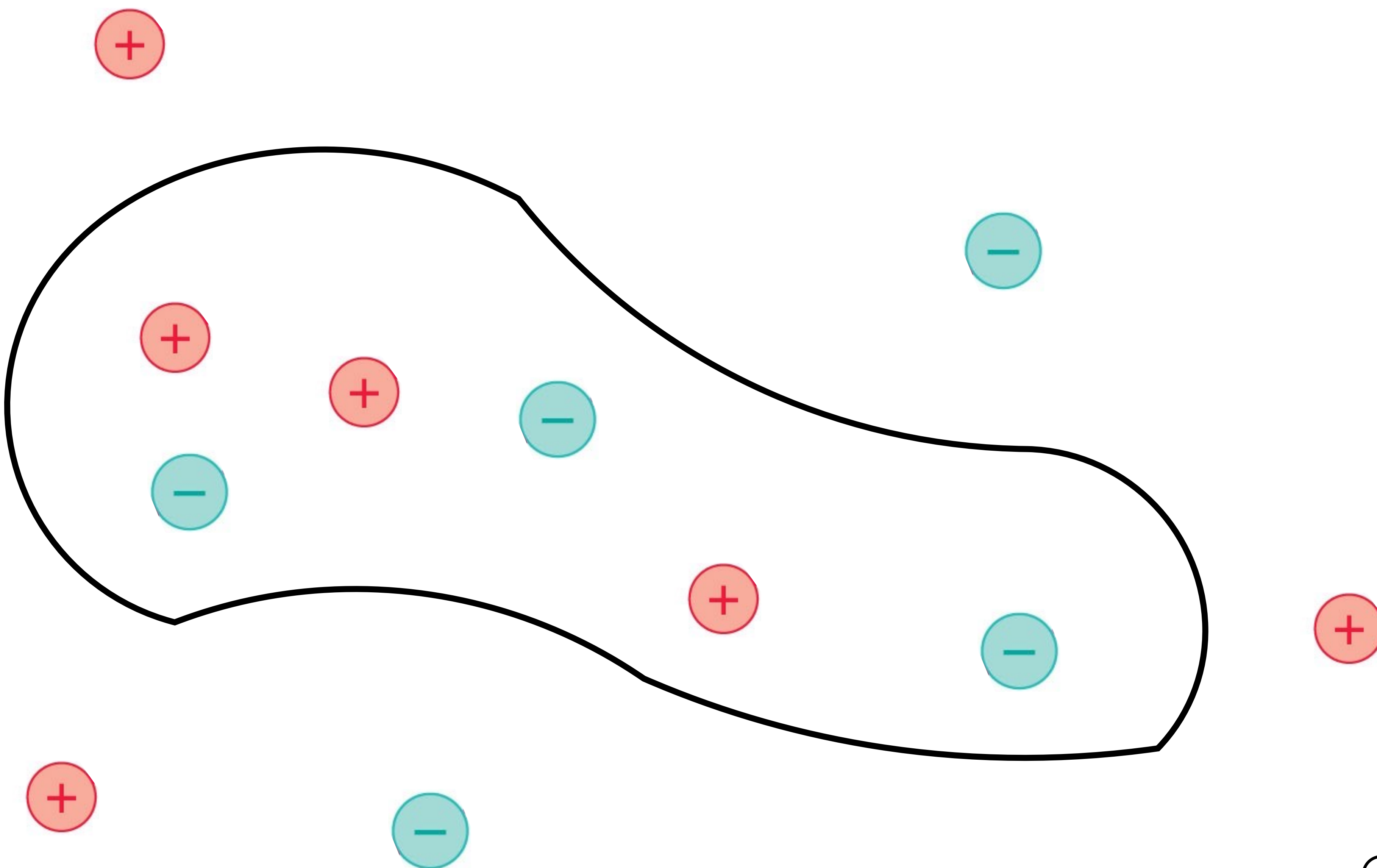
big deal!

$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{\text{in}}}{\epsilon_0}$$

The magnitude of every charge in the figure is 5.0 nC.

What is the net electric flux through the surface shown?

Question #31



A $\frac{-5\ \text{nC}}{\epsilon_0}$

B 0

C $\frac{+5\ \text{nC}}{\epsilon_0}$

D $\frac{-15\ \text{nC}}{\epsilon_0}$

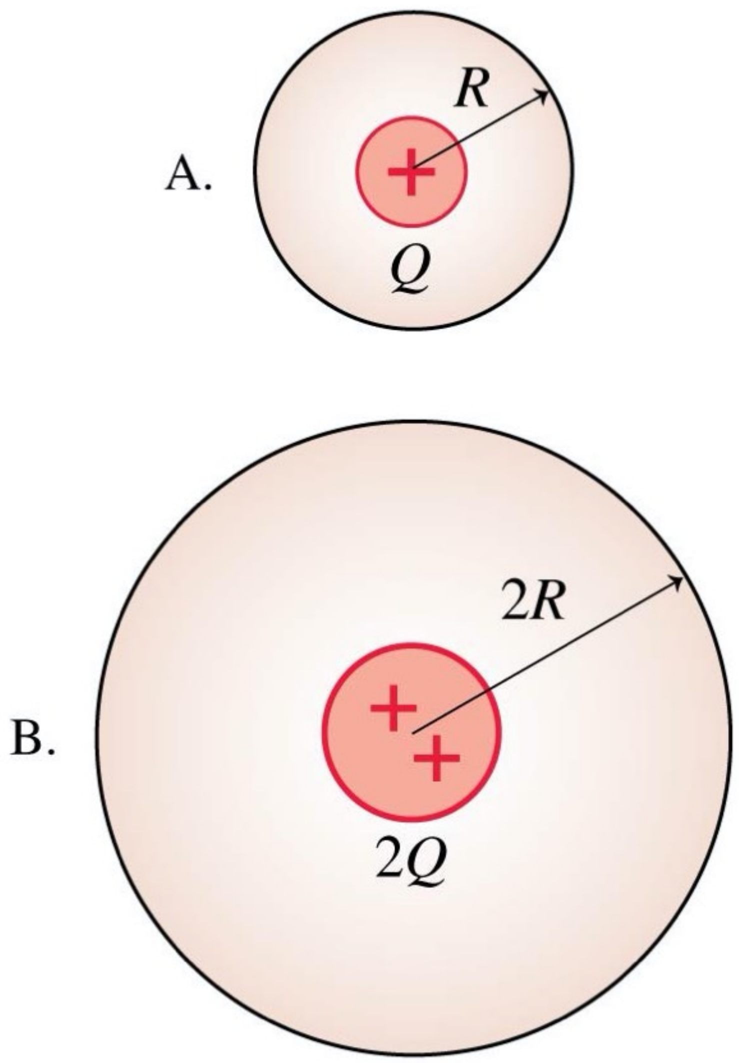
E $\frac{+15\ \text{nC}}{\epsilon_0}$

$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{\text{in}}}{\epsilon_0}$$

Question #32

Which spherical Gaussian surface has the larger electric flux?

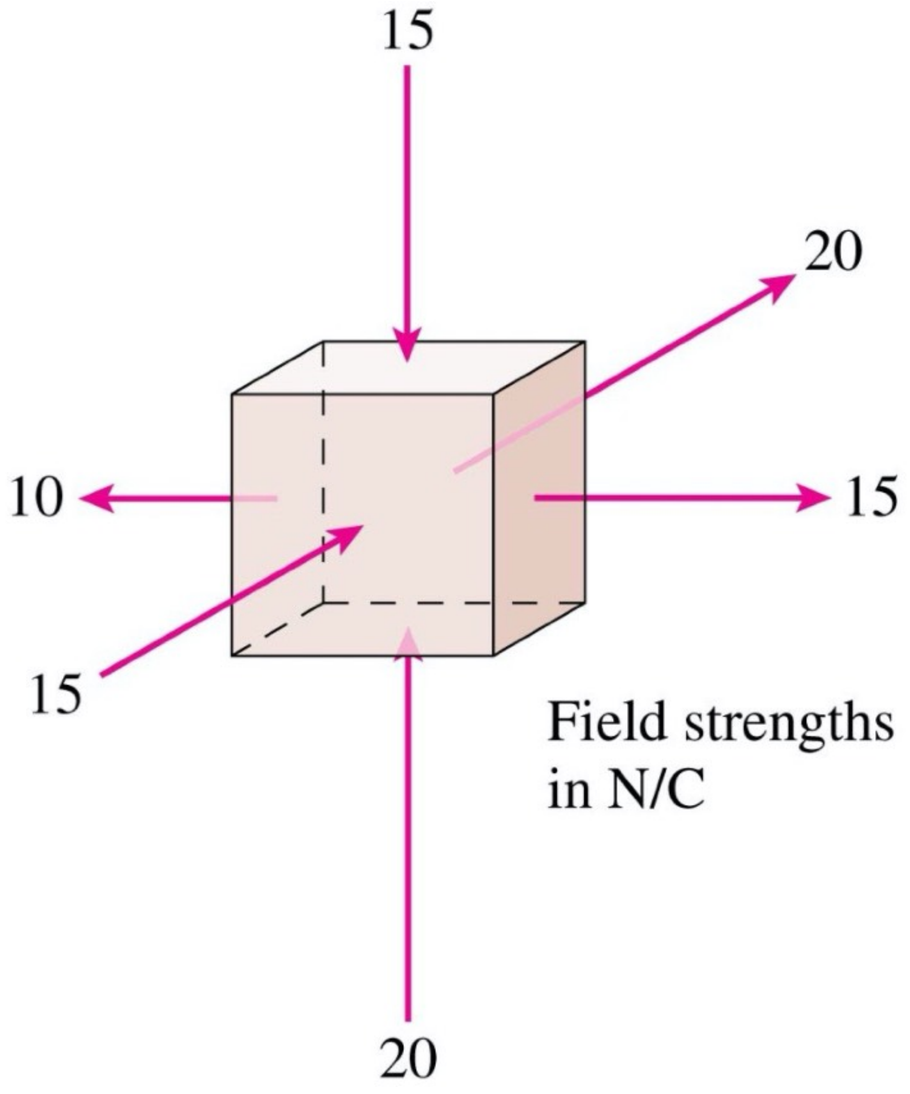
B. Surface A.
C. Surface B.
D. They have the same flux.
E. Not enough information to tell.



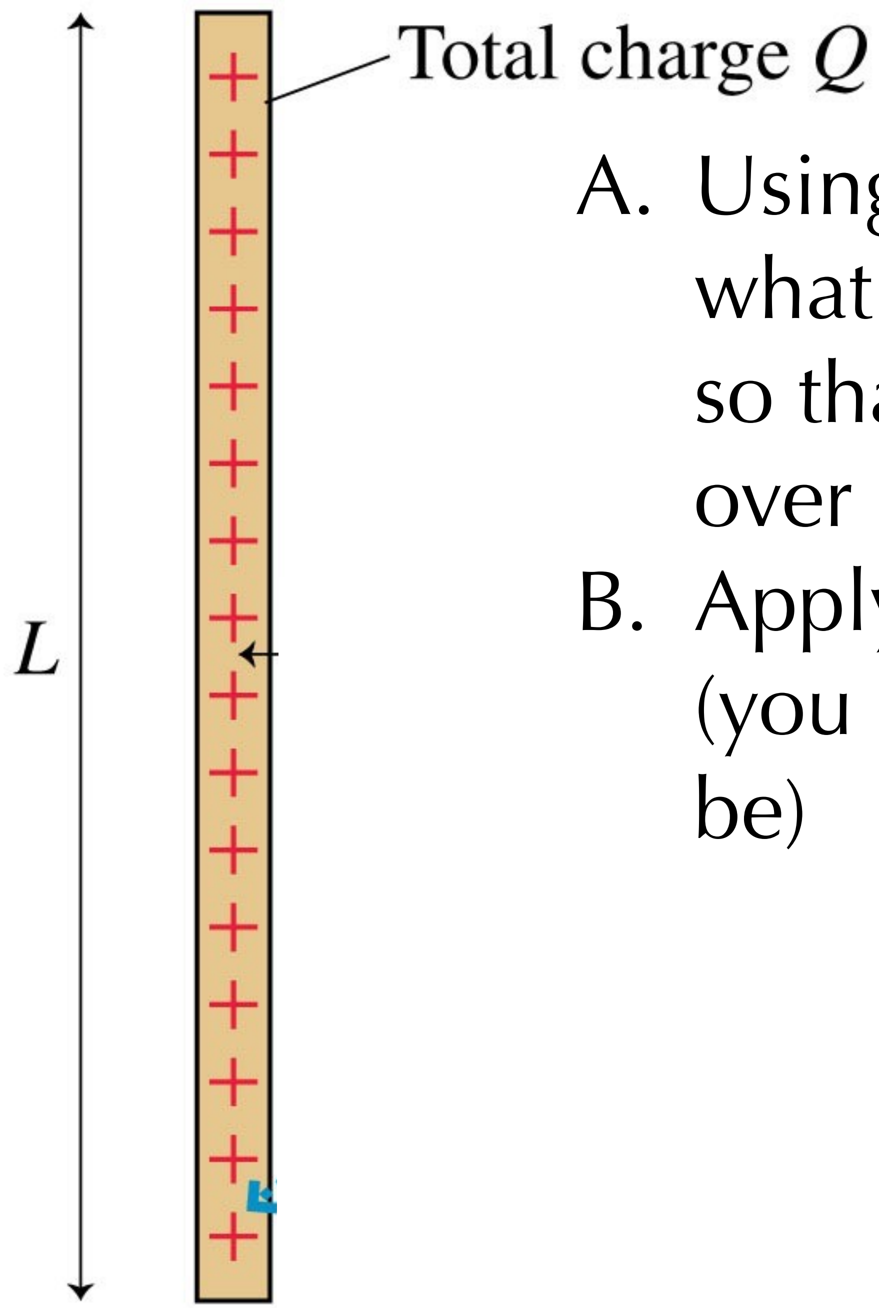
Question #33

The electric field is constant
over each face of the box.
The box contains

A. Negative charge.
B. Positive charge.
C. No net charge.
D. Not enough information to tell.



What else is Gauss's Law good for?



A. Using symmetry considerations, what closed surface can you choose so that the electric field is constant over it.
B. Apply Gauss's law to find the E field. (you already know what it should be)

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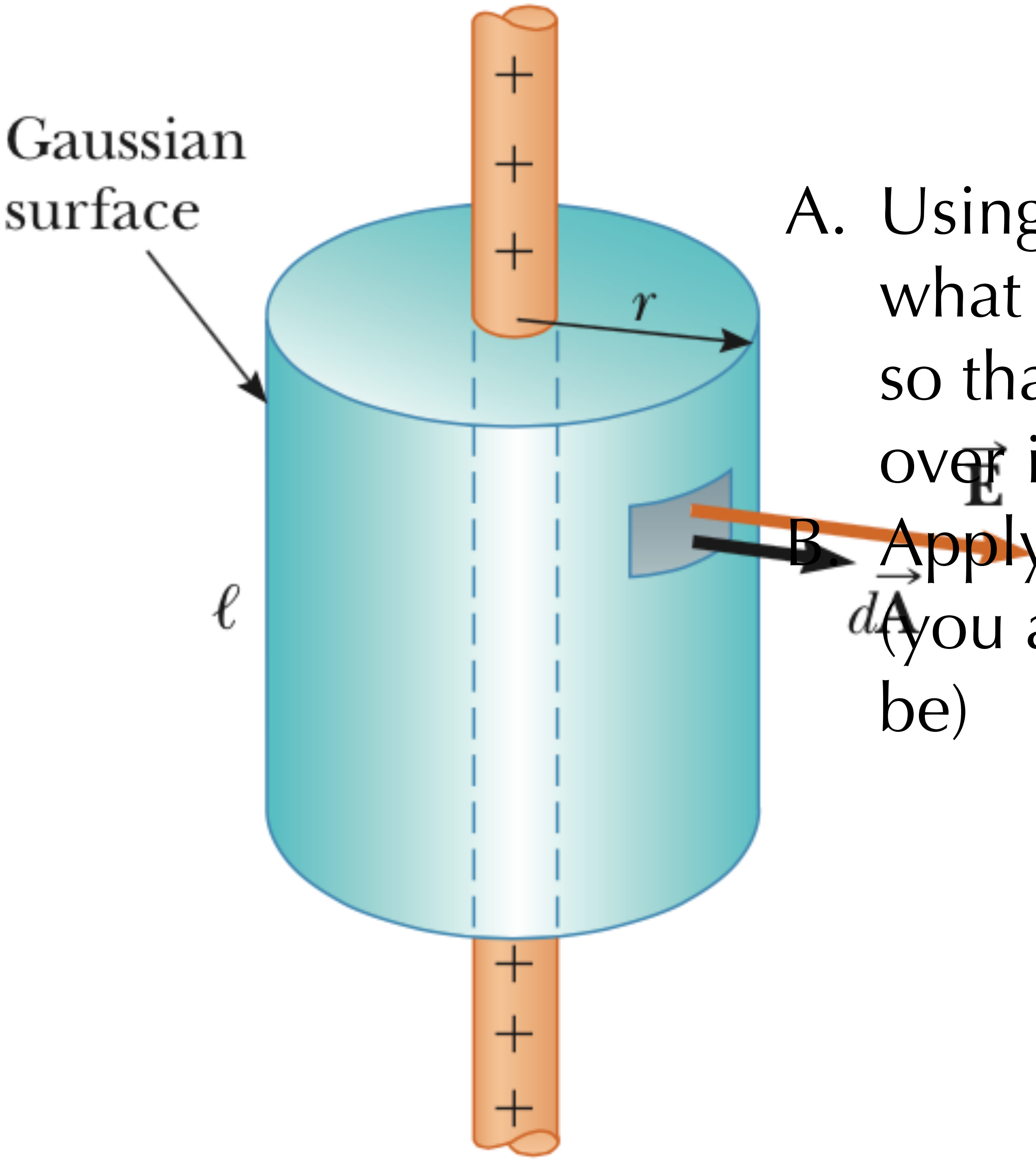

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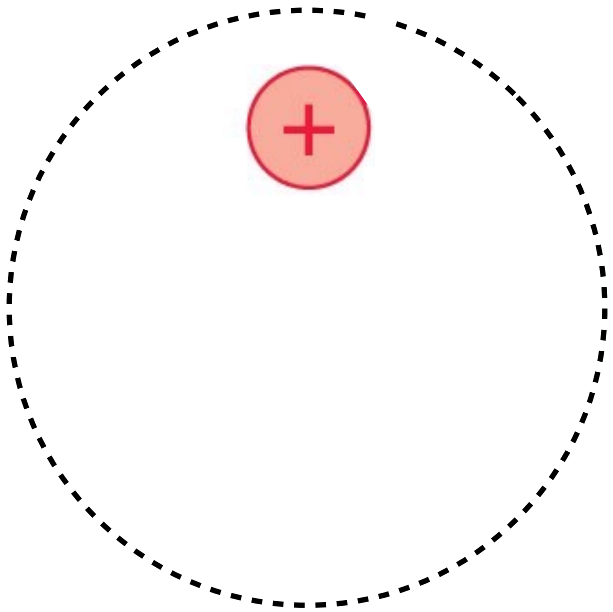
How/When is Gauss's law helpful

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



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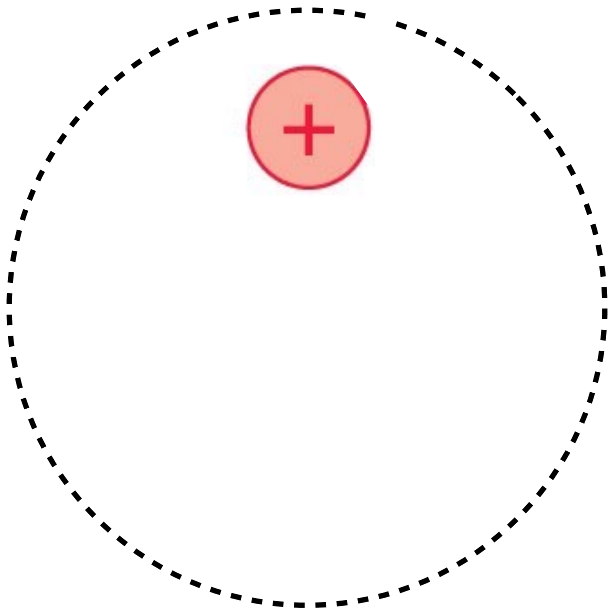
Is Gauss's Law helpful if I choose this surface?



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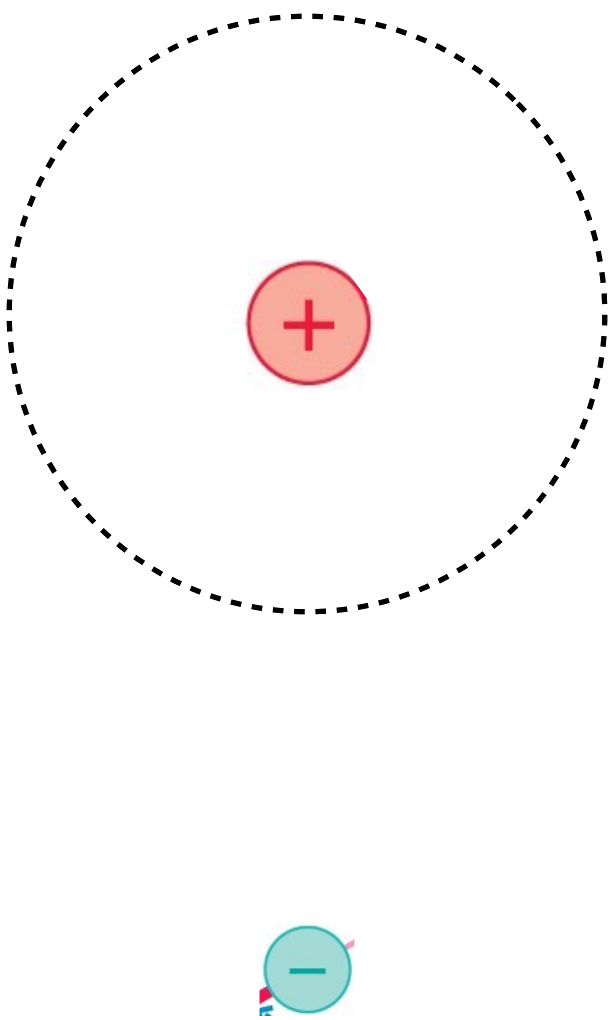

Is Gauss's Law helpful for this charge distribution?

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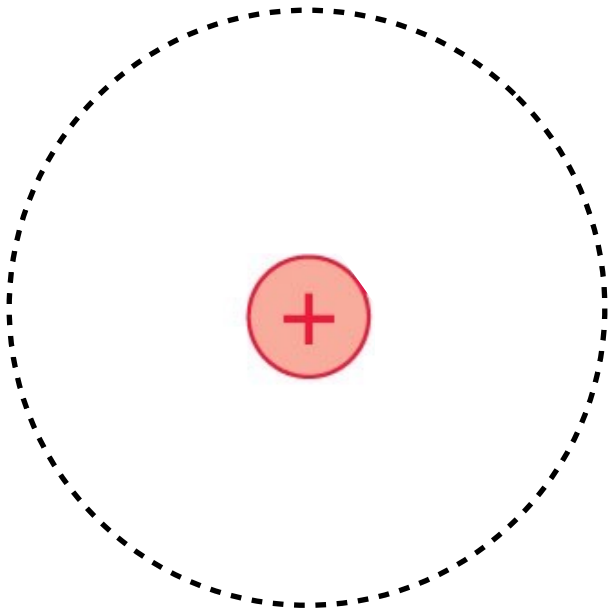


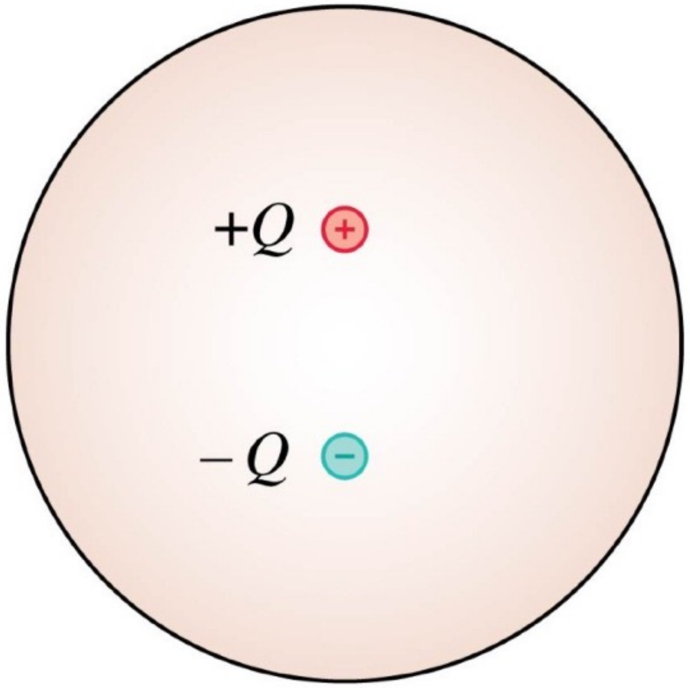
Is Gauss's Law helpful for this charge distribution?

Gauss's Law is most useful when the surface is chosen such that the integral becomes trivial (easy).

Question #33

A spherical Gaussian surface surrounds an electric dipole. The net enclosed charge is zero. Which is true?

A. The electric field is not zero everywhere on the Gaussian surface.
B. The electric field is zero everywhere on the Gaussian surface.
C. Whether or not the field is zero on the surface depends on where the dipole is inside the sphere.



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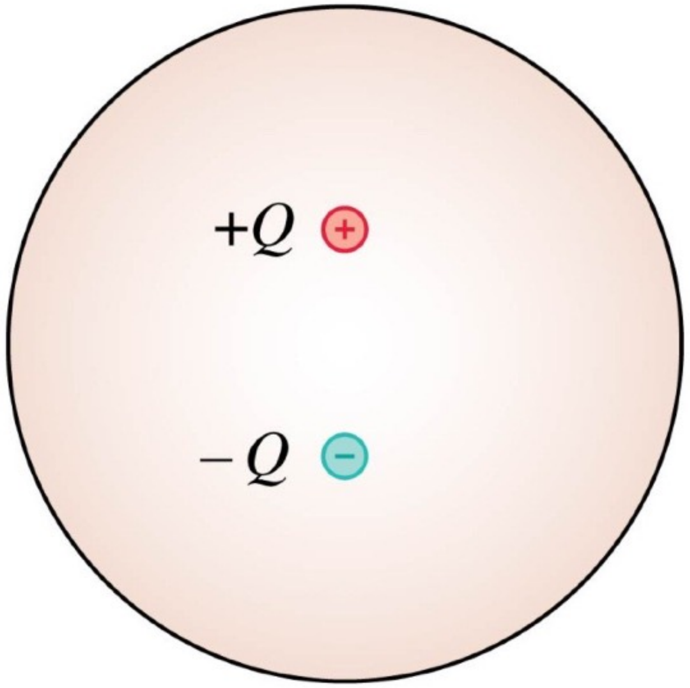
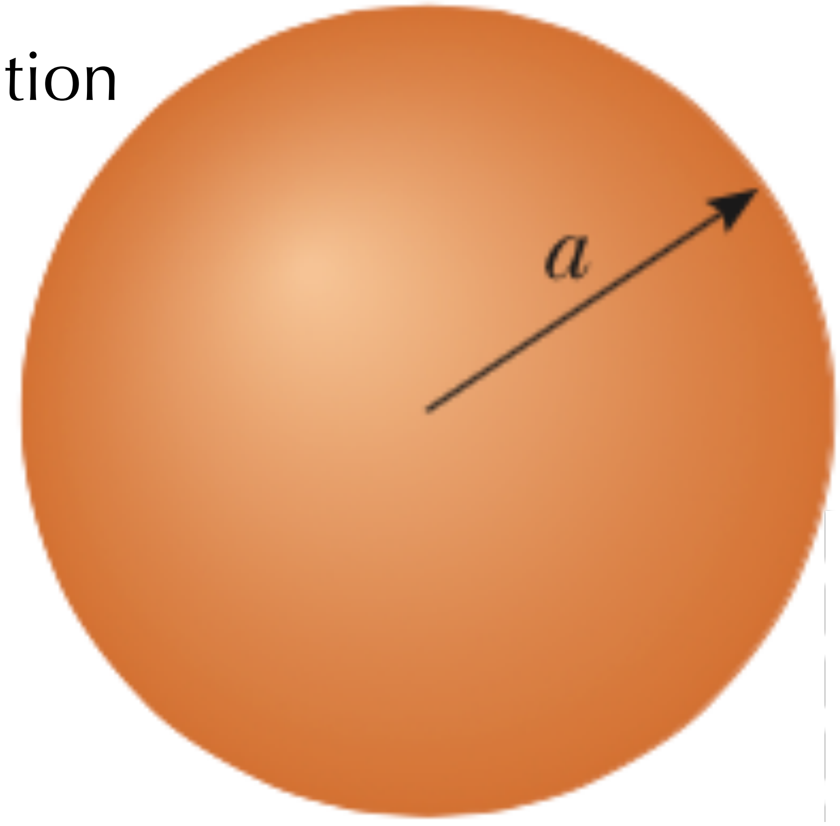


What direction must the E field point?

Use Gauss's law to determine what the electric field is inside and outside of the sphere

uniform charge distribution



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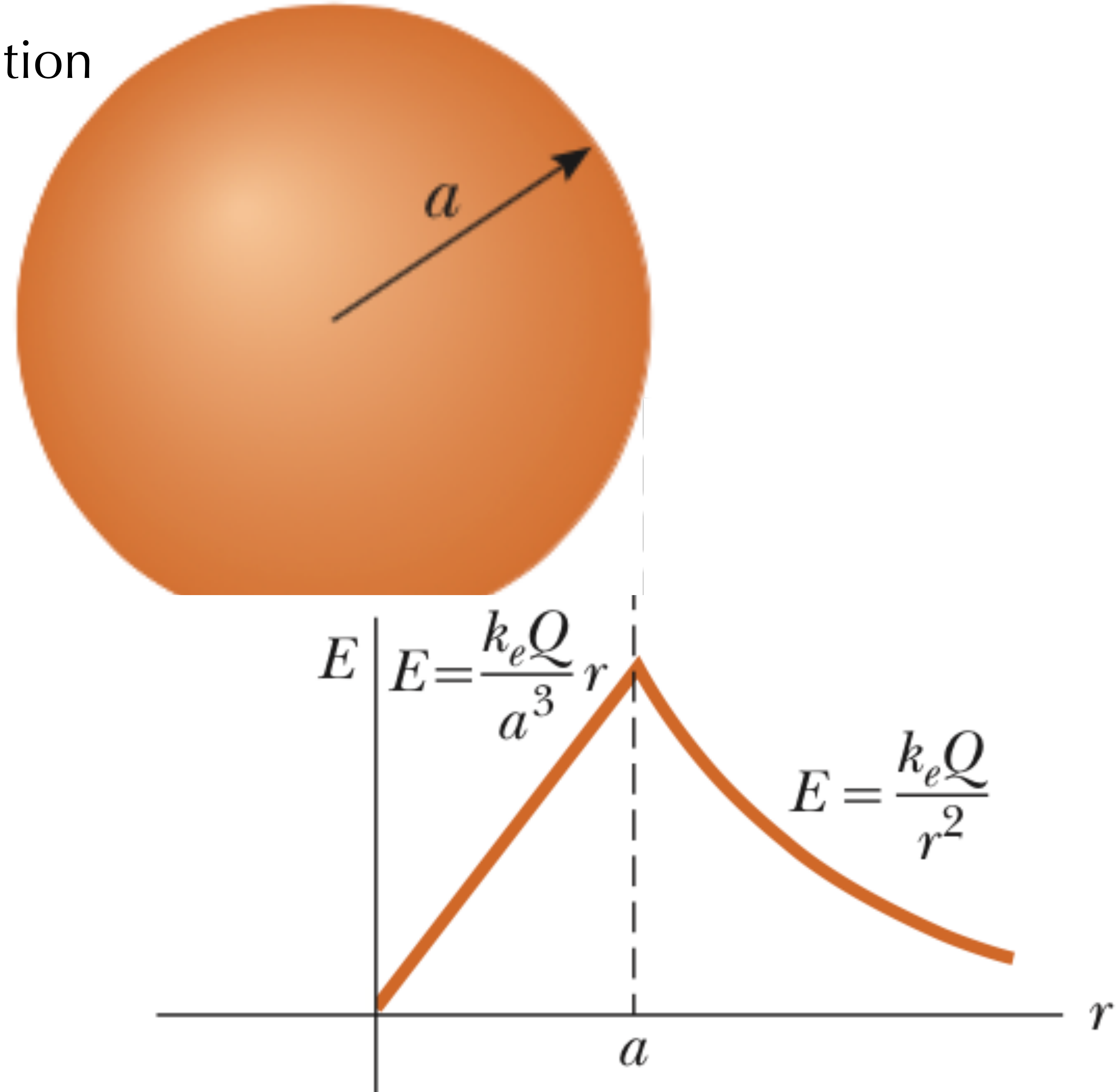
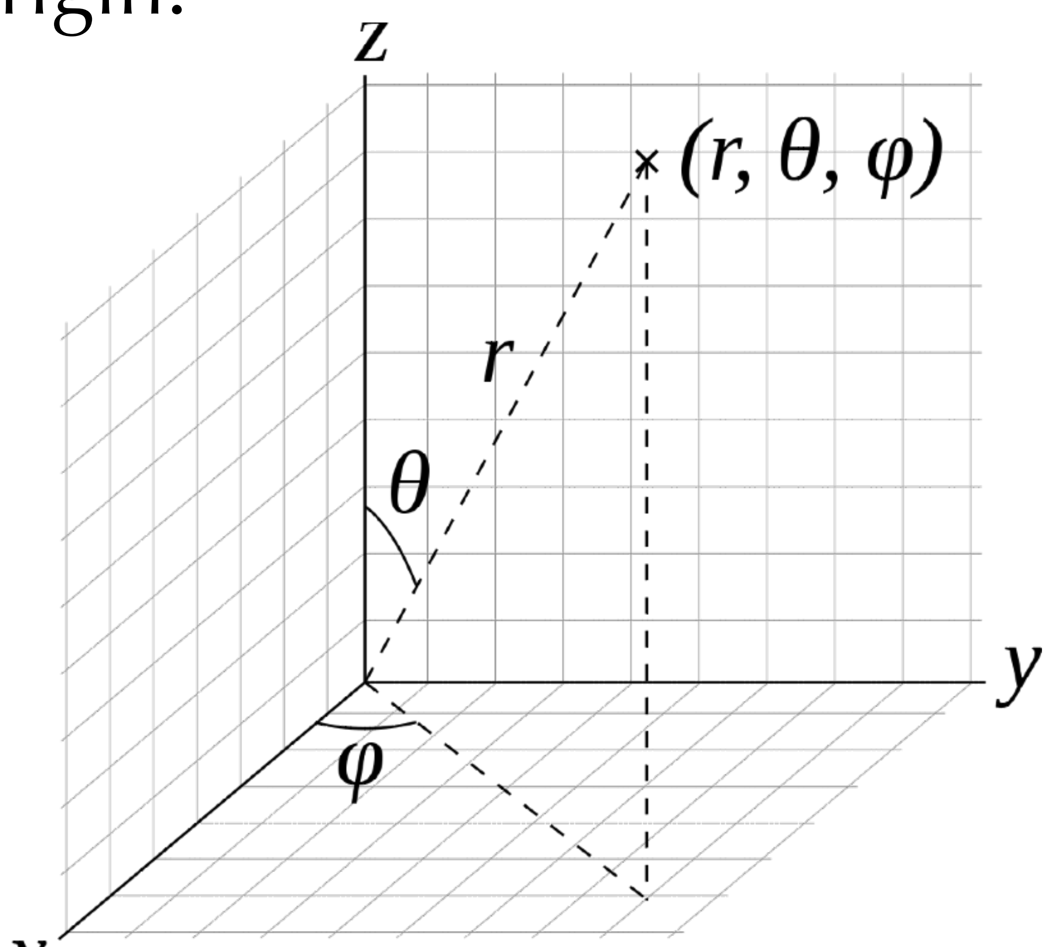


A. What symmetry does this charge distribution have?
B. What gaussian surface would you choose?
C. Apply Gausses law to determine what the electric field is a distance of R from the origin.

$$\rho = \frac{1}{r}$$

Try to form a mental picture of this charge distribution



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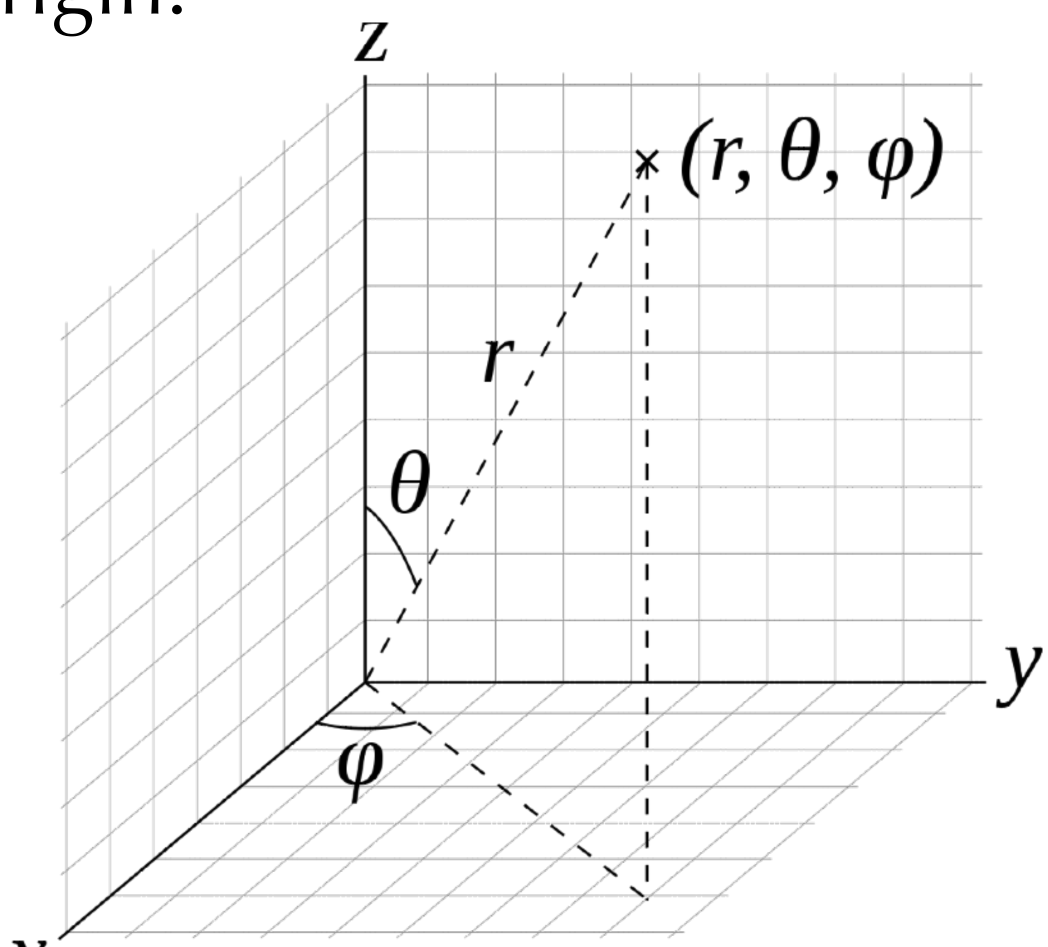

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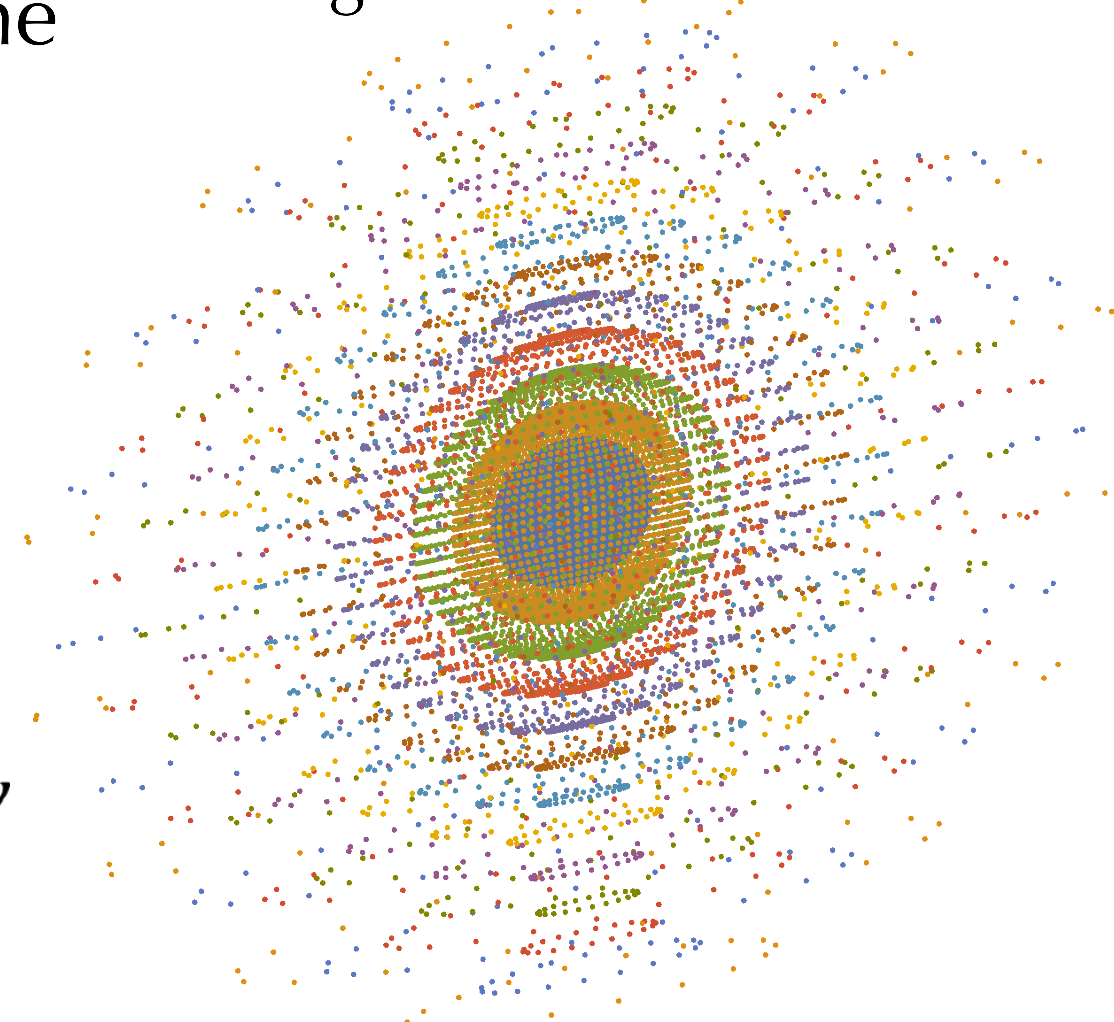
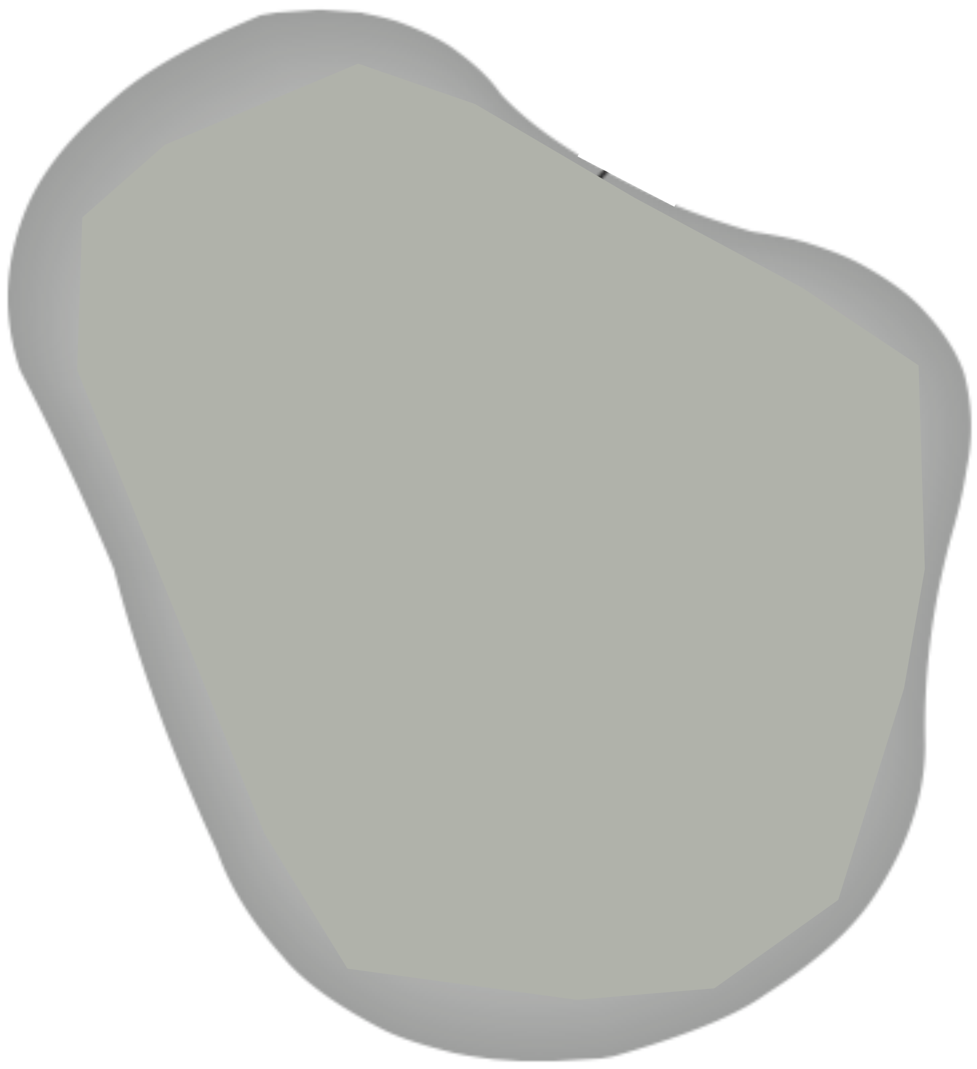


Conductors in equilibrium

conductor

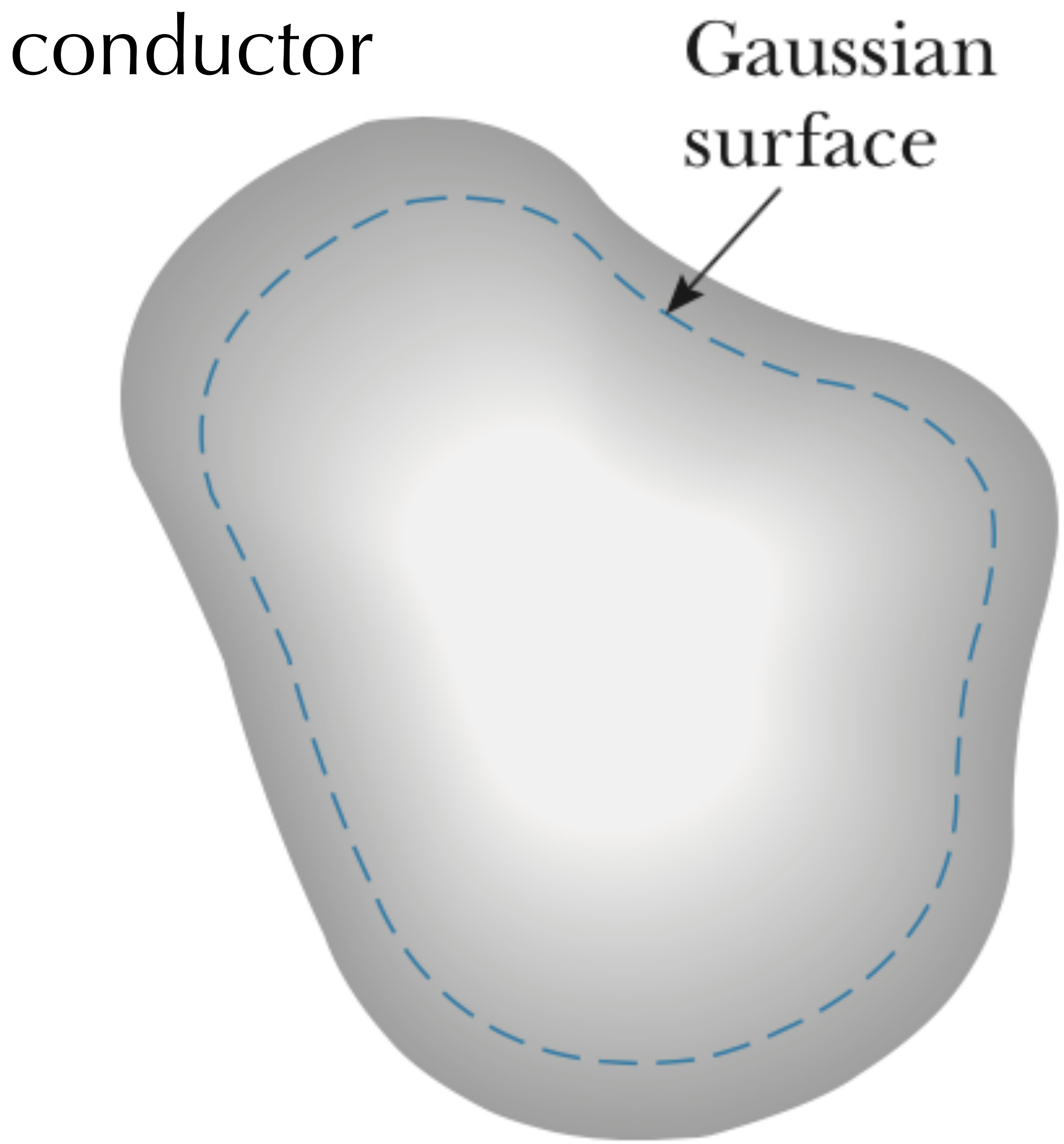


If I charge this conductor, where will the charge reside once equilibrium is reached? Explain your reasoning.

Hint: Define equilibrium in this situation.

Use Gauss's law to explain/ justify your answer.

Conductors in equilibrium



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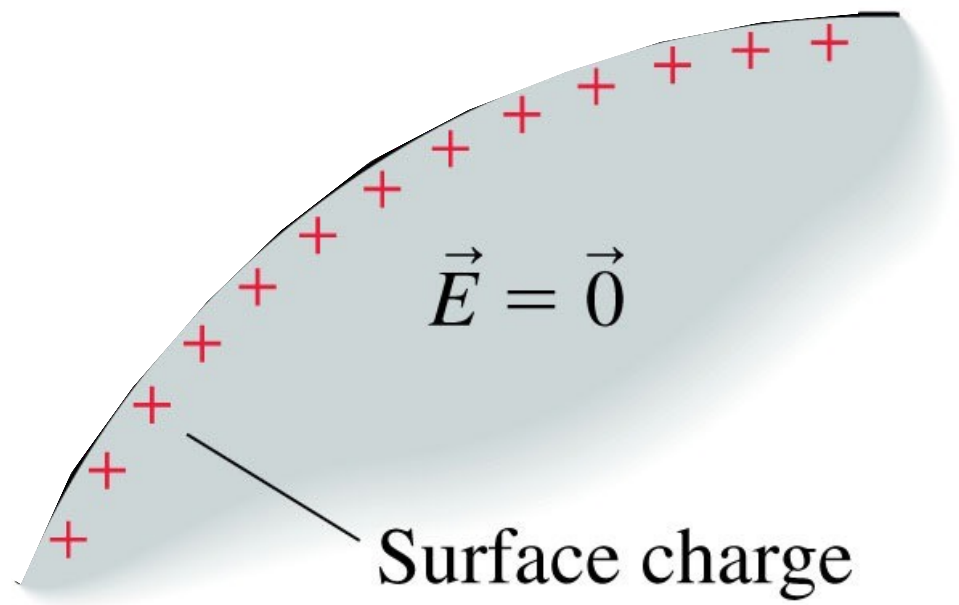
Conductors in Equilibrium

What direction does the E field point at the surface of the conductor?

Explain how you know.



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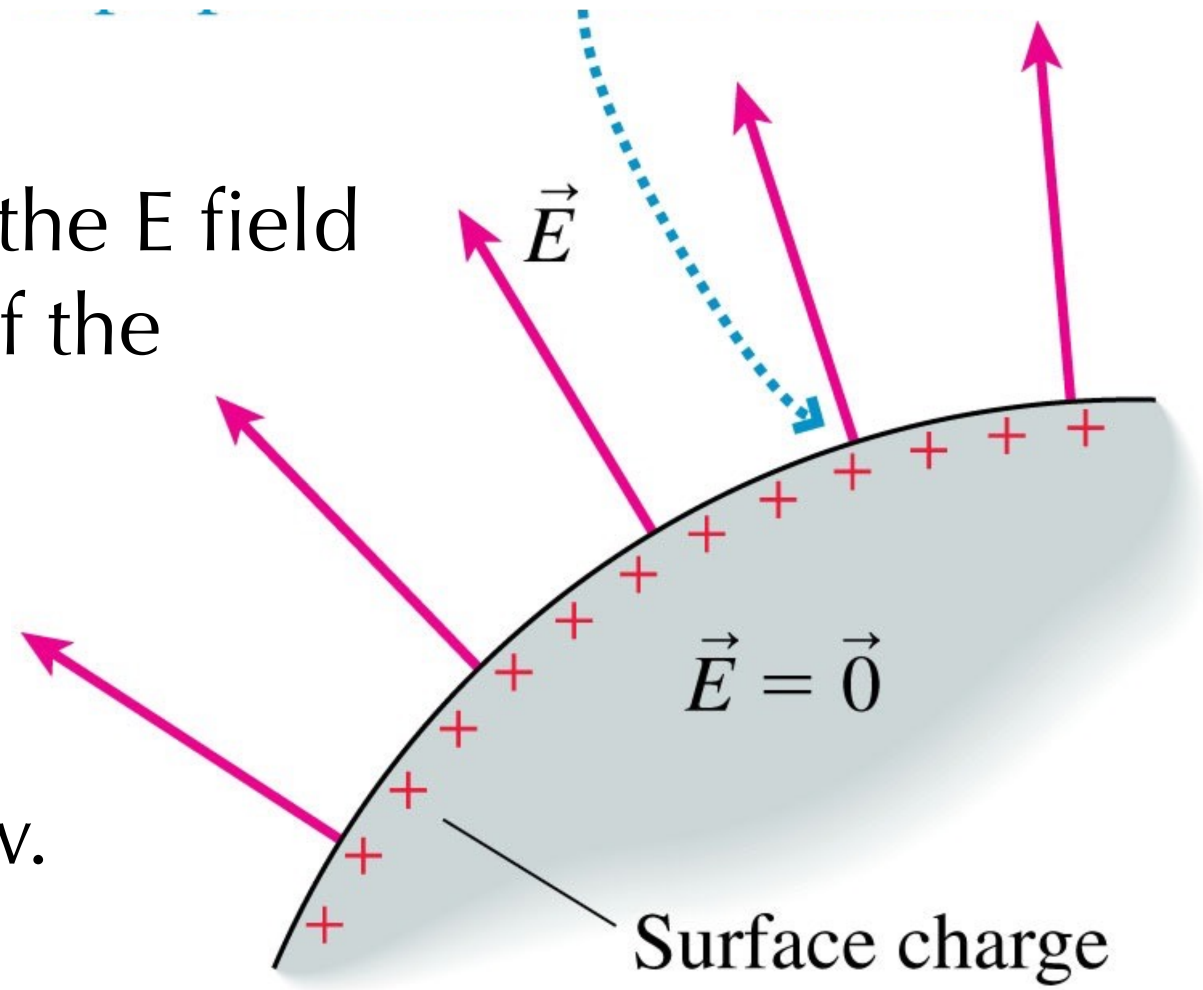

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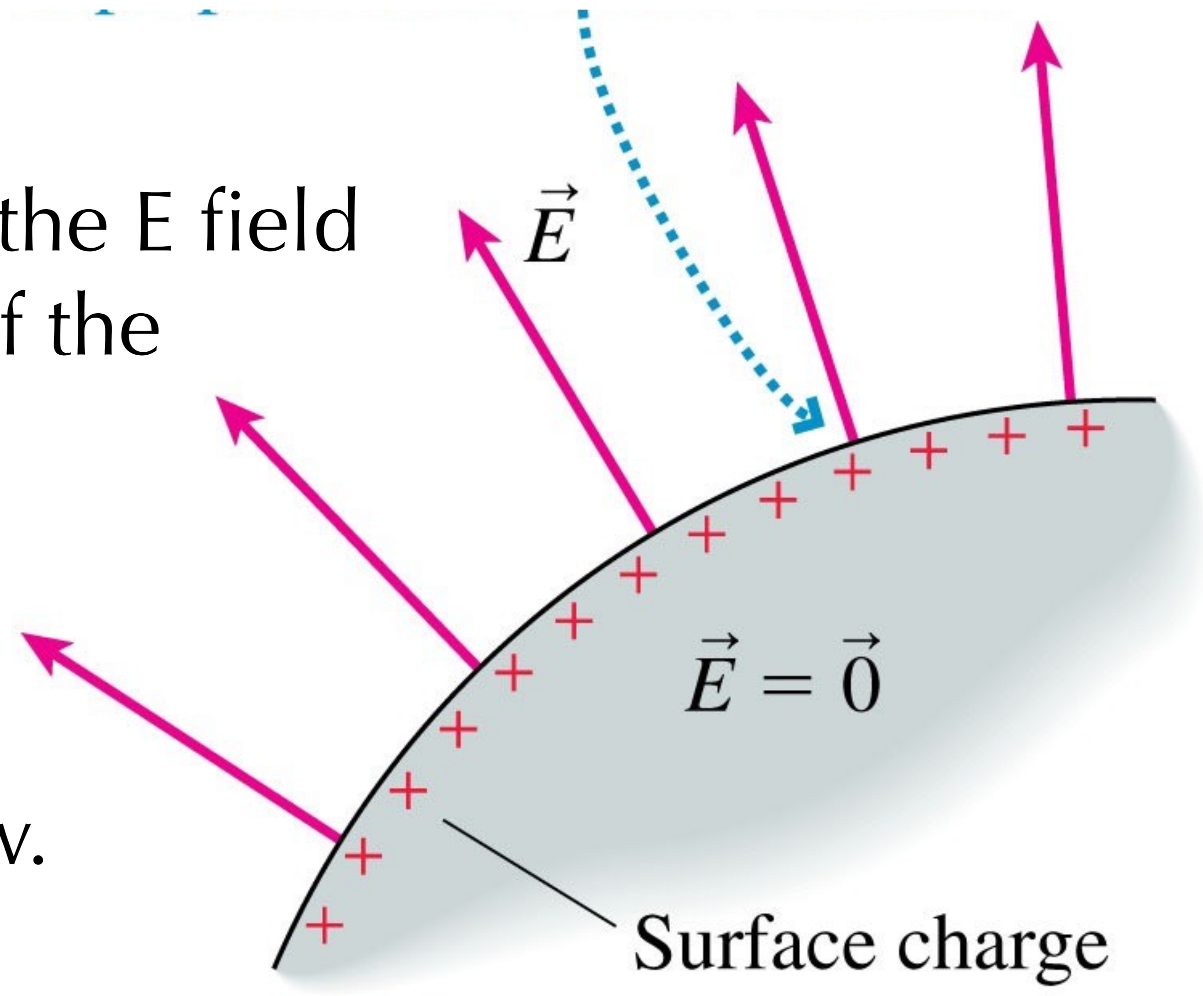

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Use Gauss's Law to find an expression for the electric field at the surface of the conductor.

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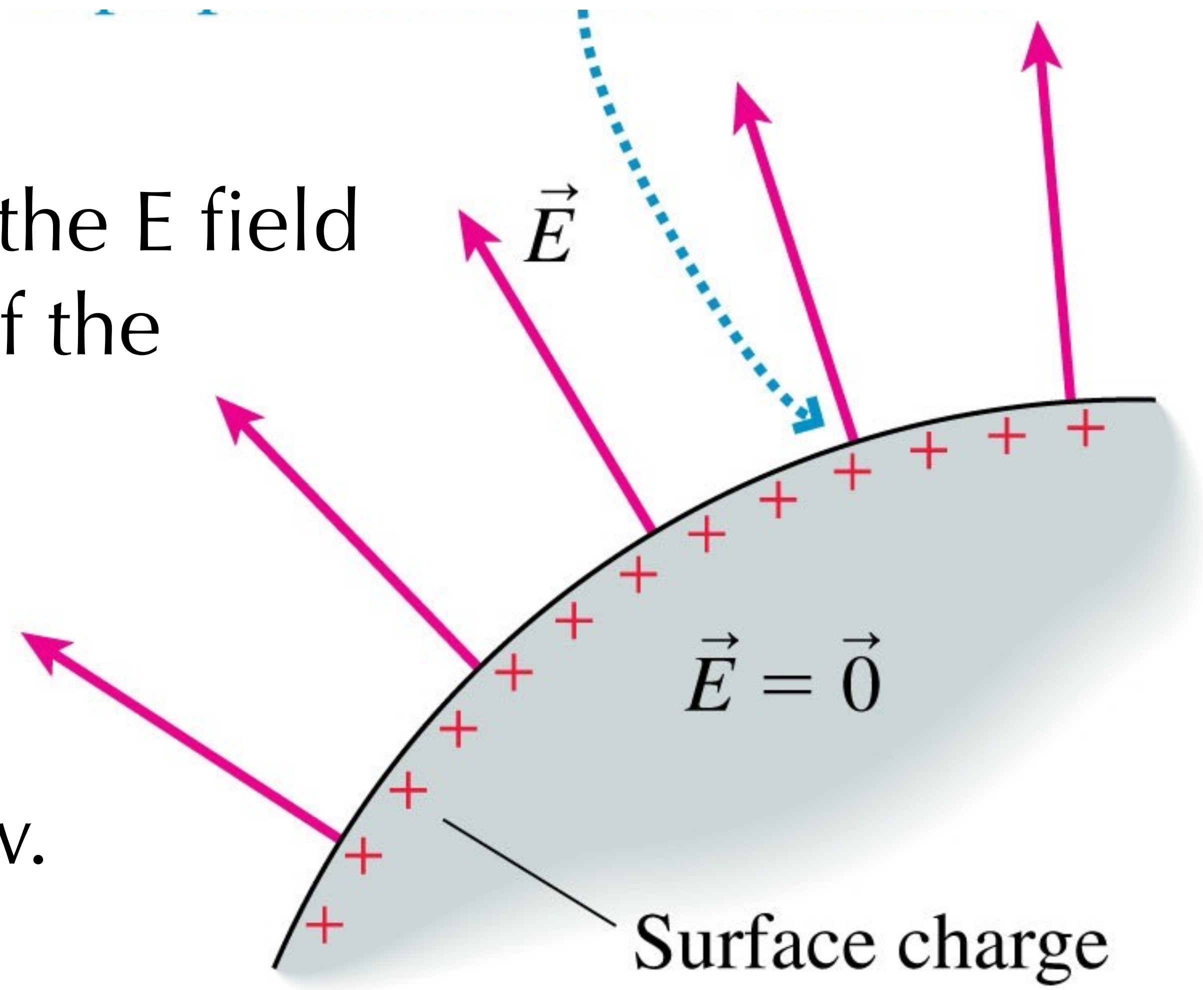


Explain how you know.

Use Gauss's Law to find an expression for the electric field at the surface of the conductor.

$$\vec{E} = \frac{\eta}{\epsilon_0}$$ perpendicular to surface

Question #34

A point charge q is located distance r from the center of a neutral metal sphere. The electric field at the
center of the sphere is

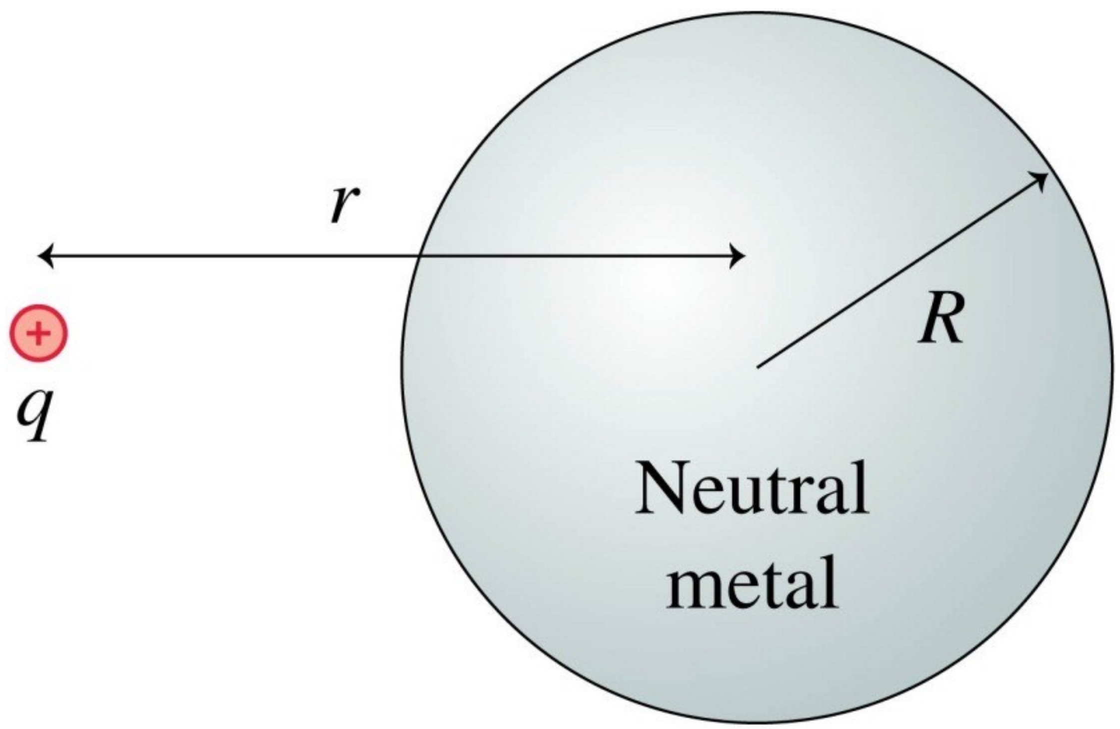
A. $\dfrac{q}{4\pi\epsilon_0 R^2}$.

B. $\dfrac{q}{4\pi\epsilon_0 r^2}$.

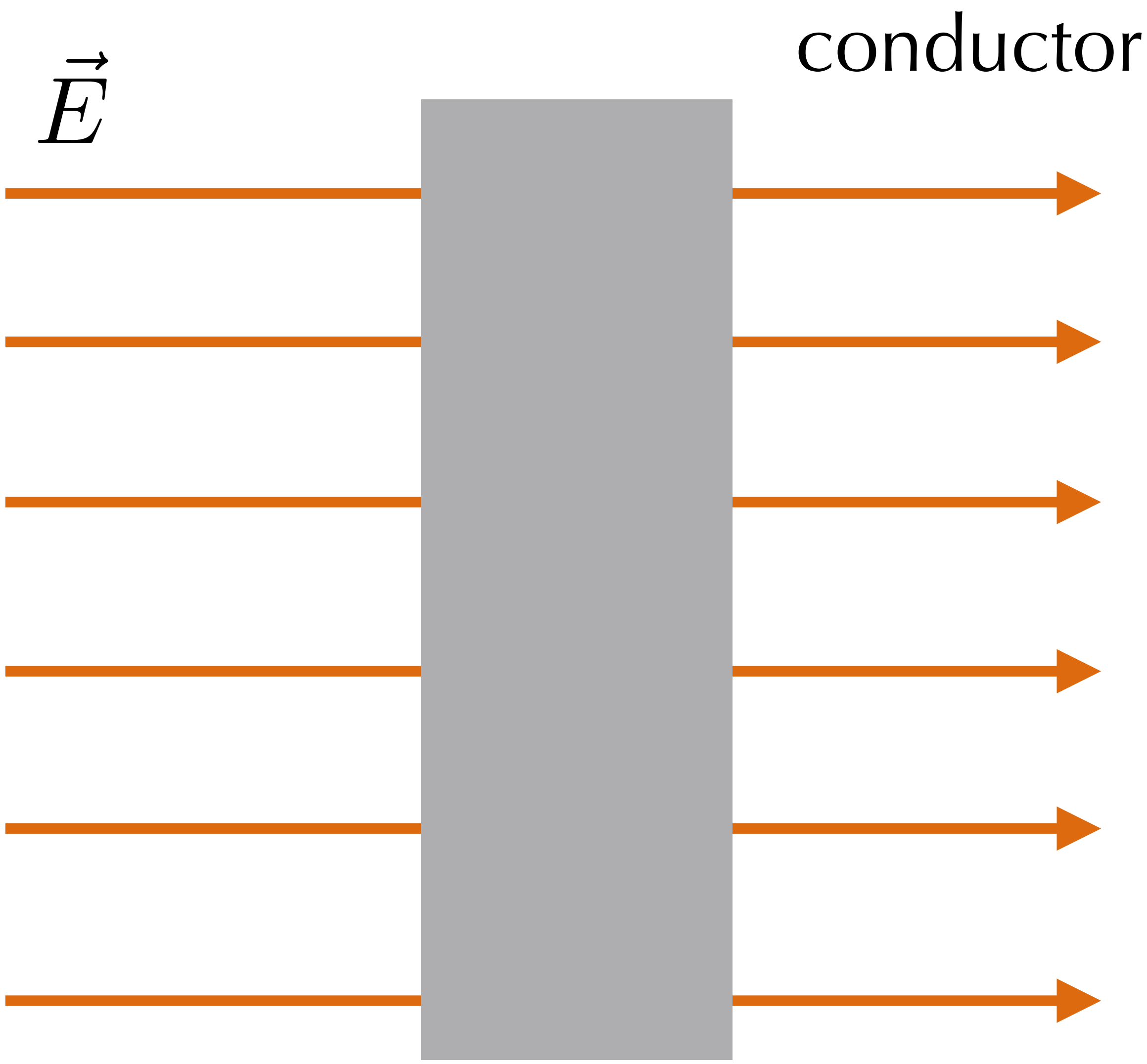
C. $\dfrac{q}{4\pi\epsilon_0 (R-r)^2}$.

D. 0.

E. It depends on what the metal is.



Faraday Cage



What will be the electric field inside the conductor?

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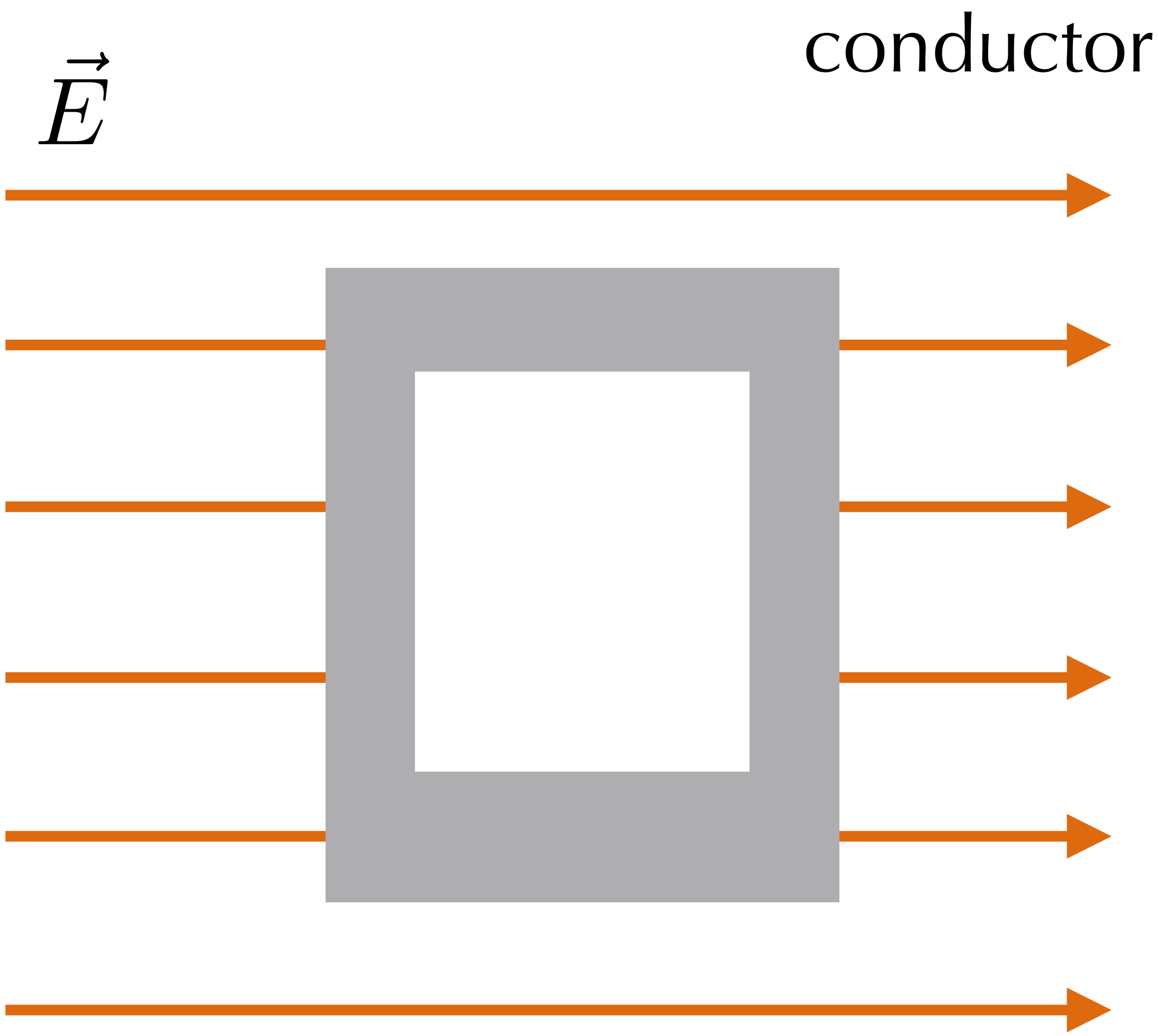

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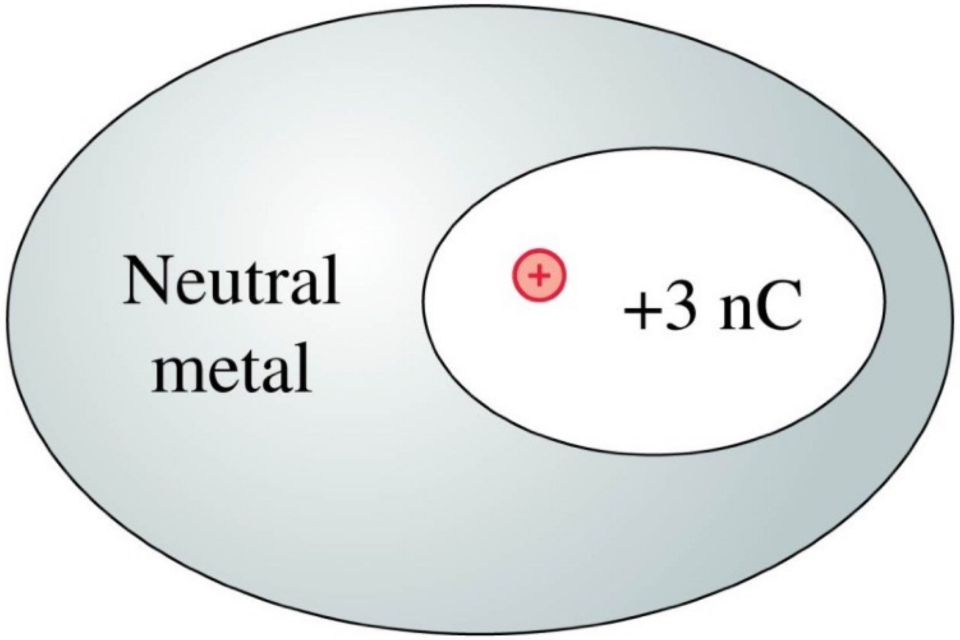
Question #35

Charge +3 nC is in a hollow cavity inside a large chunk of metal that is electrically neutral. The total charge on the exterior surface of the metal is



A. Can't say without knowing the shap and location of the hollow cavity.

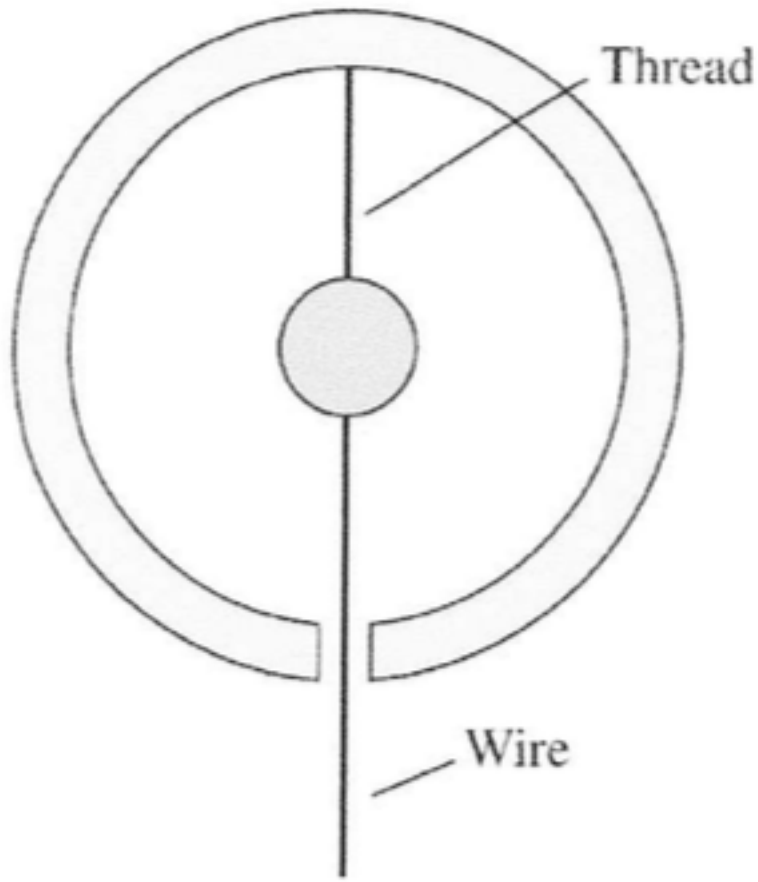
B. 0 nC.

C. –3 nC.

D. +3 nC.

If I touch the wire with a positively-charged rod, what charges will the following surfaces carry?

1. small sphere
2. inner surface of shell
3. outer surface of shell.



a. positive
b. negative
c. neutral