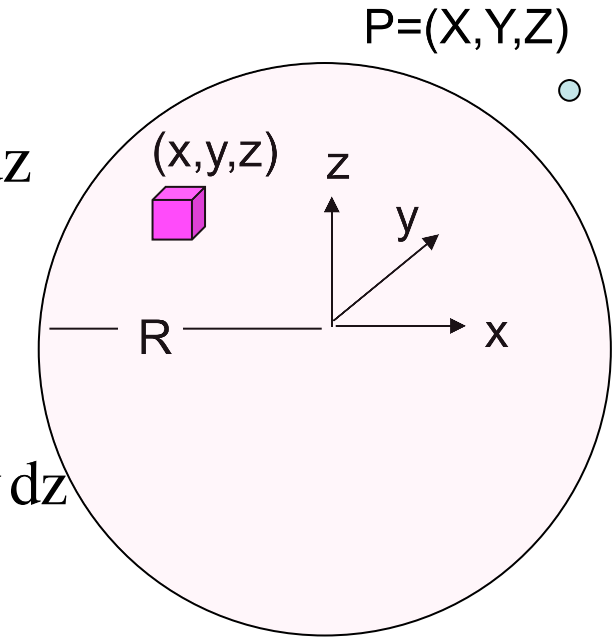
2.15

$$\mathbf{E} = \frac{1}{4\pi\varepsilon_0}\int \frac{1}{\Re^2}\hat{\Re}\,\rho\,\mathrm{d}\tau \quad = \frac{1}{4\pi\varepsilon_0}\bullet(....?)$$



A) $$\int \frac{(X,Y,Z)}{\left((X-x)^2+(Y-y)^2+(Z-z)^2\right)}\rho\,\mathrm{dx}\,\mathrm{dy}\,\mathrm{dz}$$

B) $$\int \frac{(X,Y,Z)}{\left((X-x)^2+(Y-y)^2+(Z-z)^2\right)^{3/2}}\rho\,\mathrm{dx}\,\mathrm{dy}\,\mathrm{dz}$$

C) $$\int \frac{(X-x,Y-y,Z-z)}{\left((X-x)^2+(Y-y)^2+(Z-z)^2\right)}\rho\,\mathrm{dx}\,\mathrm{dy}\,\mathrm{dz}$$

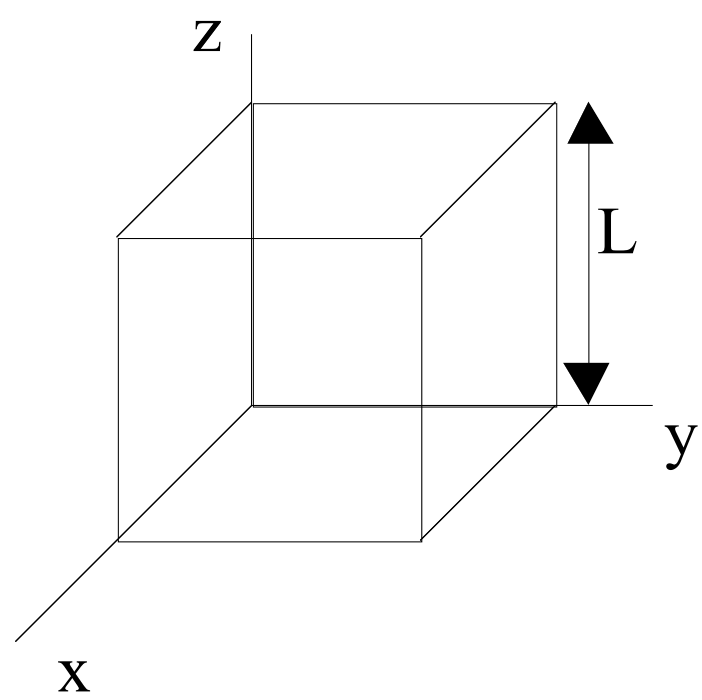
D) $$\int \frac{(X-x,Y-y,Z-z)}{\left((X-x)^2+(Y-y)^2+(Z-z)^2\right)^{3/2}}\rho\,\mathrm{dx}\,\mathrm{dy}\,\mathrm{dz}$$

E) None of these

Which of the following are vectors?
(I) Electric field
(II) Electric flux
(III) Electric charge

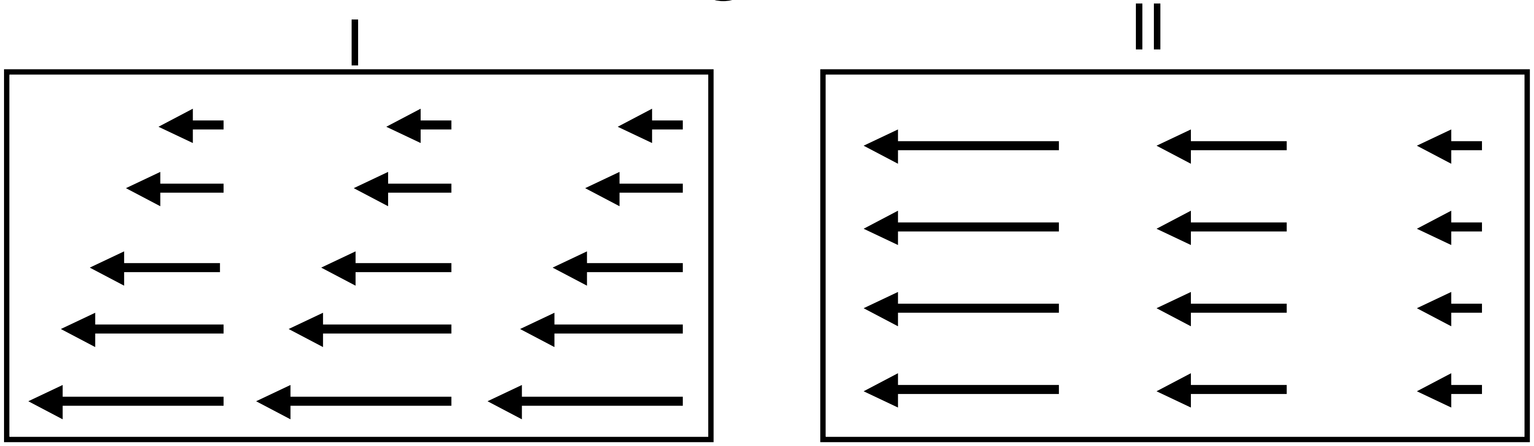
A) (I) only
B) (I) and (II) only
C) (I) and (III) only
D) (II) and (III) only
E) (I), (II), and (III)

The space in and around a cubical box (edge length L) is filled with a constant uniform electric field, $\vec{E} = E\hat{y}$. What is the TOTAL electric flux $\oiint \vec{E} \cdot d\vec{a}$ through this closed surface?



A. Zero
B. EL^2
C. $2EL^2$
D. $6EL^2$
E. We don't know $\rho(r)$, so can't answer.

Which of the following two fields has zero divergence?



A) Both do

B) Only I is zero

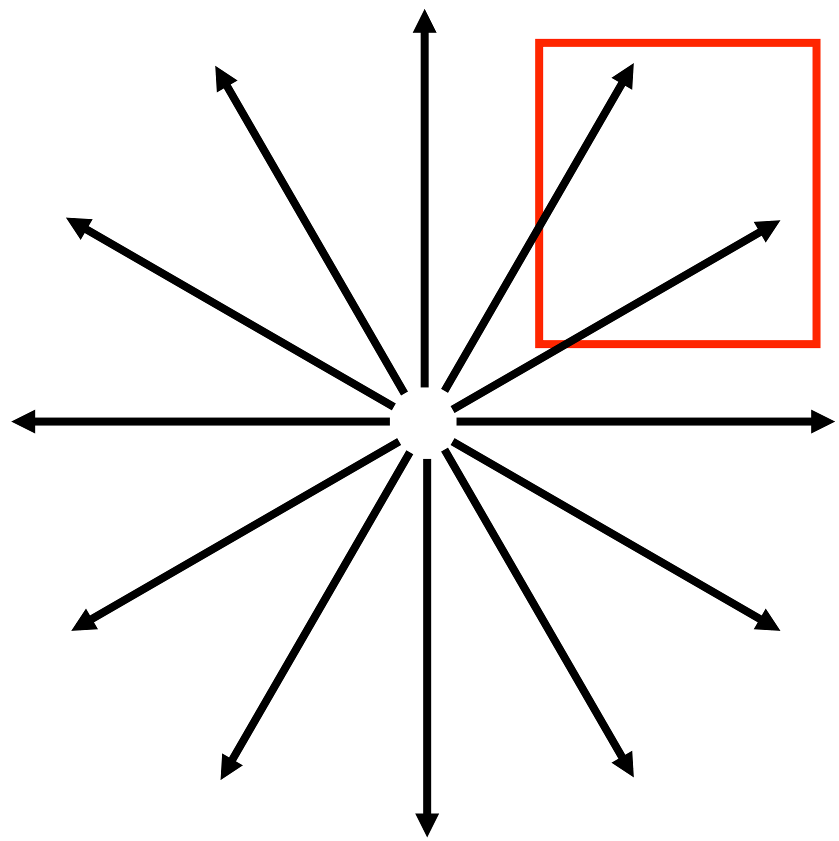
C) Only II is zero

D) Neither is zero

E) ??

What is the divergence of this vector field *in the boxed region?*

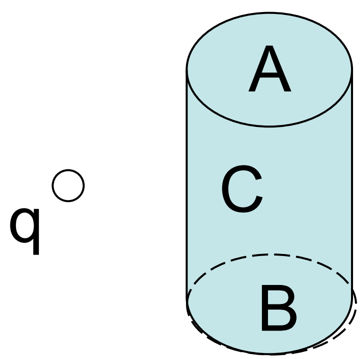
A) Zero
B) Not zero
C) ???

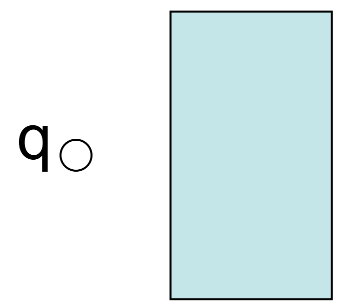


A positive point charge +q is placed outside a closed cylindrical surface as shown. The closed surface consists of the flat end caps (labeled A and B) and the curved side surface (C). What is the sign of the electric flux through surface C?

(A) positive (B) negative (C) zero

(D) not enough information given to decide



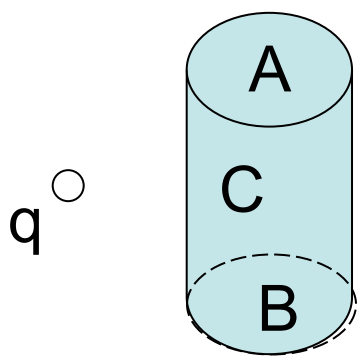


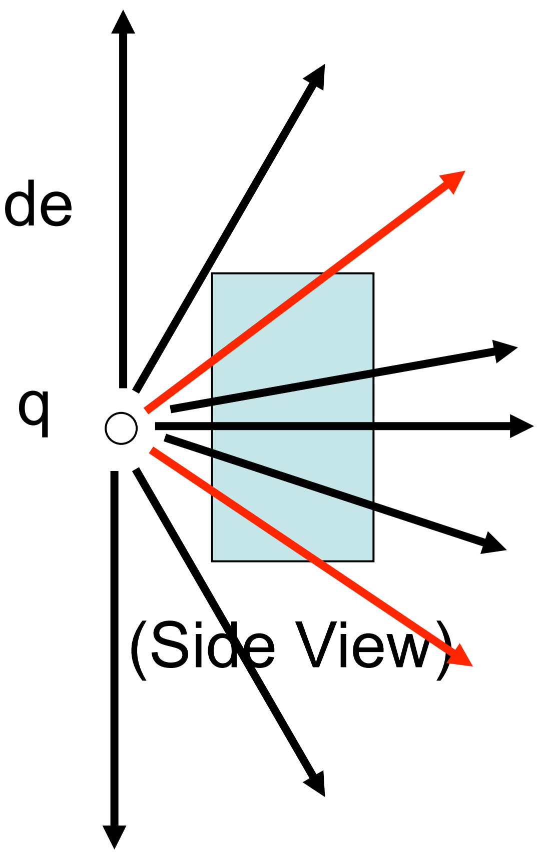
(Side View)

A positive point charge +q is placed outside a closed cylindrical surface as shown. The closed surface consists of the flat end caps (labeled A and B) and the curved side surface (C). What is the sign of the electric flux through surface C?

(A) positive (B) negative (C) zero

(D) not enough information given to decide





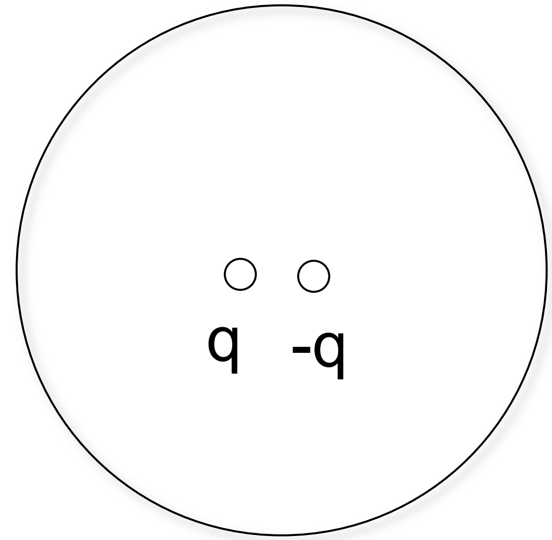
A Gaussian surface which is *not* a sphere has a single charge (q) inside it, *not* at the center. There are more charges outside. What can we say about total electric flux through this surface $\oint \vec{E} \bullet d\vec{a}$?

A) It is q/ε0

B) We know what it is, but it is NOT q/ε0

C) Need more info/details to figure it out.

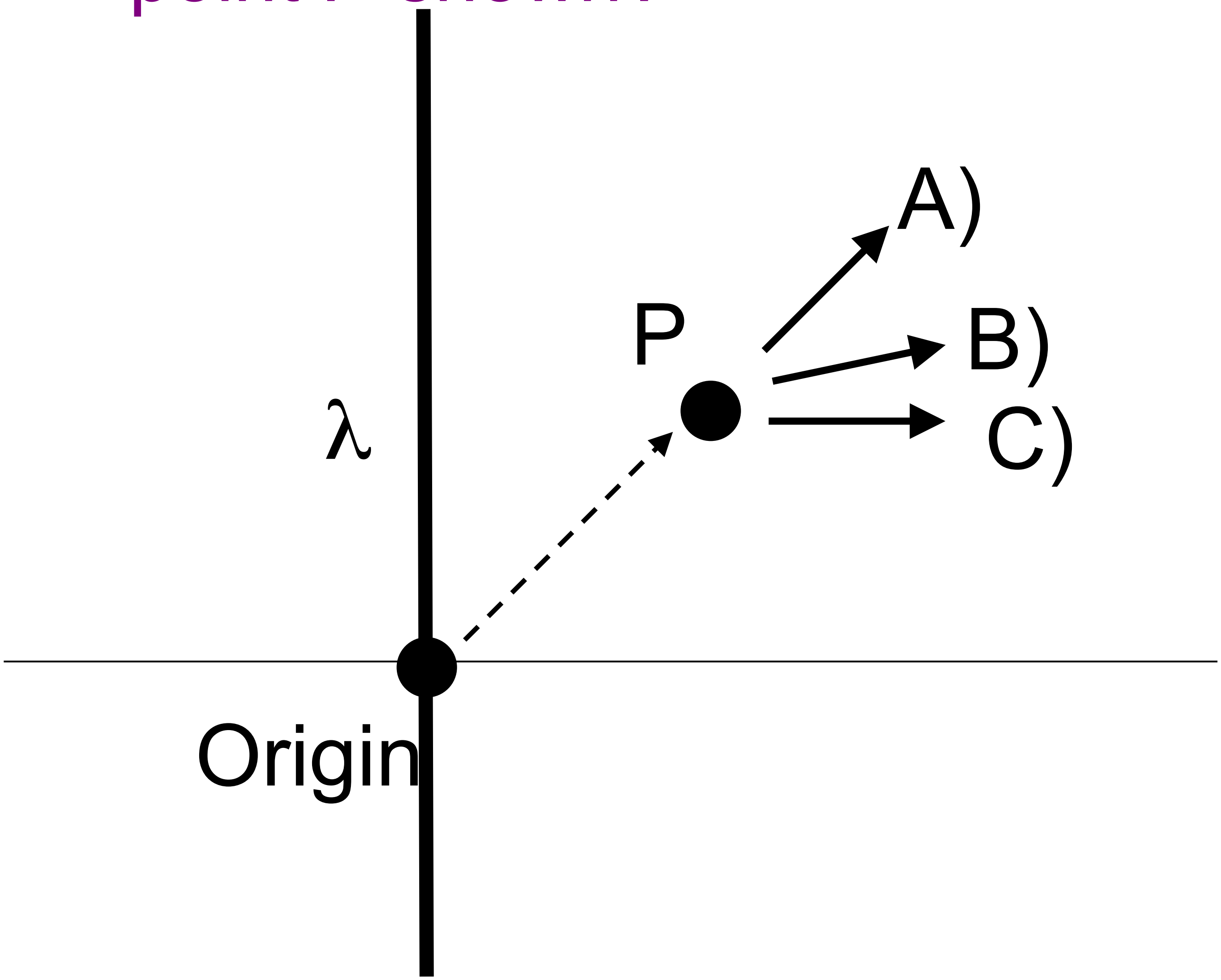
An electric dipole
(+q and –q, small distance d apart)
sits centered in a Gaussian sphere.



What can you say about the flux of E through the sphere, and |E| on the sphere?

A) Flux=0, E=0 everywhere on sphere surface
B) Flux =0, E need not be zero on sphere
C) Flux is not zero, E=0 everywhere on sphere
D) Flux is not zero, E need not be zero…

2.17 An infinite rod has uniform charge density λ. What is the direction of the E field at the point P shown?



A point charge (q) is located at position **R**, as shown. What is ρ(r), the charge density in all space?

A) $\rho(\vec{\mathbf{r}}) = q\delta^3(\vec{\mathbf{R}})$

B) $\rho(\vec{\mathbf{r}}) = q\delta^3(\vec{\mathbf{r}})$

C) $\rho(\vec{\mathbf{r}}) = q\delta^3(\vec{\mathbf{r}} - \vec{\mathbf{R}})$

D) $\rho(\vec{\mathbf{r}}) = q\delta^3(\vec{\mathbf{R}} - \vec{\mathbf{r}})$

E) None of these/more than one/???

Deep questions to ponder

- Is Coulomb's force law valid for *all* separation distances? (How about r=0?)
- What is the physics origin of the r^2 dependence of Coulomb's force law?
- What is the physics origin of the $1/\varepsilon_0$ dependence of Coulomb's force law?
- What is the physics origin of the $1/4\pi$ factor in Coulomb's force law?
- What really *is* electric charge?
- Why is electric charge quantized (in units of *e*)?
- What really is *negative* vs. *positive* electric charge (i.e. –*e* vs. +*e*)?
- Why does the Coulomb force vary as the *product* of charges q_1q_2?
- What really is the *E*-field associated with e.g. a point electric charge, *e*?
- Are electric field lines real? Do they *really* exist in space and time?