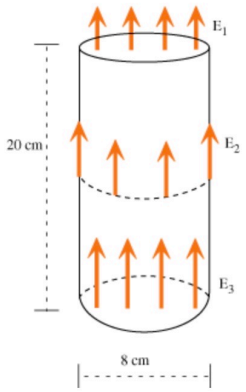
The electric field is measured all over the surface of a cylinder whose diameter is 8 cm and whose height is 20 cm, as shown in the diagram. At every location on the surface the electric field points in the same direction (+y). E_1 is found to be 534V/m; E_2 is 766V/m; E_3 is 1223V/m.



(a) Which of the following statements are true?

- [ ] The angle between E_1 and $\hat{n}$ is 90 degrees.
- [ ] The flux on the flat ends of the cylinder is 0.
- [ ] Only the curved surface of the cylinder gives a nonzero contribution to the net electric flux.
- [ ] Not enough information is given to solve this problem.
- [x] The angle between E_2 and $\hat{n}$ is 90 degrees.
- [ ] This is an impossible pattern of electric field.
- [x] The net flux on this cylindrical surface is negative.

(b) What is the net electric flux on this surface?

net electric flux = -3.46329 Vm

(c) How much charge is inside the surface? ε_0 = 8.85e-12 $C^2/N\ m^2$.

Q_{inside} = C

Part Two

$$\Phi_{total} = \Phi_{top} + \Phi_{bottom}$$

$$= \vec{E}_1 \cdot \vec{n}_1 A_1 + \vec{E}_3 \cdot \vec{n}_2 A_2$$

$$= |\vec{E}_1| A_1 - |\vec{E}_2| A_2$$

$$= -3.463 \text{ Vm}$$

Part Four

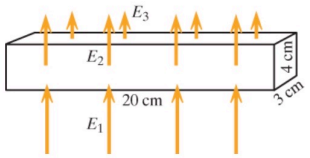
$$\Phi = \frac{q}{\varepsilon_0}$$

$$q = \Phi \varepsilon_0$$

$= -30.65e-12\ C$

Simple applications

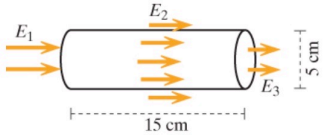
(a) The electric field has been measured to be vertically upward everywhere on the surface of a box 20 cm long, 4 cm high, and 3 cm deep, shown in the figure. All over the bottom of the box E_1 = 1600 V/m, all over the sides E_2 = 800 V/m, and all over the top E_3 = 450 V/m.



What is the amount of charge enclosed by the box? Use the accurate value $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N·m^2.

[ ] C

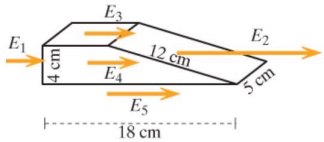
(b) The electric field is horizontal and has the values indicated on the surface of a cylinder shown in the figure. E_1 = 1400 N/C, E_2 = 1150 N/C, and E_3 = 900 N/C.



What is the amount of charge enclosed by the cylinder? Use the accurate value $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N·m^2.

[ ] C

(c) The electric field has been measured to be horizontal and to the right everywhere on the closed box shown in the figure. All over the left side of the box E_1 = 120 V/m, and all over the right, slanting, side of the box E_2 = 250 V/m. On the top the average field is E_3 = 200 V/m, on the front and back the average field is E_4 = 200 V/m, and on the bottom the average field is E_5 = 240 V/m.



How much charge is inside the box? Use the accurate value $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N·m^2.

[ ] C

Part One

$$\Phi_{total} = \Phi_{top} + \Phi_{bottom}$$

$$\frac{q}{\varepsilon_0} = \vec{E}_3 \cdot \hat{n}_{top} A_{top} + \vec{E}_1 \cdot \hat{n}_{bottom} A_{bottom}$$

$$q = \varepsilon_0 (|\vec{E}_3| A_{top} - |\vec{E}_1| A_{bottom})$$

$$= -61.065e-12\ C$$

Part Two

$$\Phi_{total} = \Phi_{right} + \Phi_{left}$$

$$\frac{q}{\varepsilon_0} = \vec{E}_3 \cdot \hat{n}_{right} A_{right} + \vec{E}_1 \cdot \hat{n}_{left} A_{left}$$

$$q = \varepsilon_0 (|\vec{E}_3| A_{right} - |\vec{E}_1| A_{left})$$

$$= -8.688\ C$$

Part Three

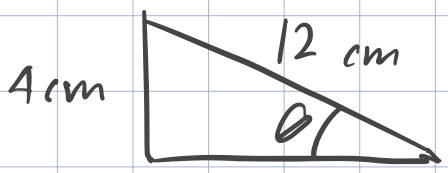
$$\Phi_{total} = \Phi_{right} + \Phi_{left}$$

$$\frac{q}{\varepsilon_0} = \vec{E}_2 \cdot \hat{n}_{right} A_{right} + \vec{E}_1 \cdot \hat{n}_{left} A_{left}$$

$$\frac{q}{\varepsilon_0} = |\vec{E}_2| \sin(\theta) A_{right} - |\vec{E}_1| A_{left}$$

$$q = \varepsilon_0 (|\vec{E}_2| \sin(\theta) A_{right} - |\vec{E}_1| A_{left})$$

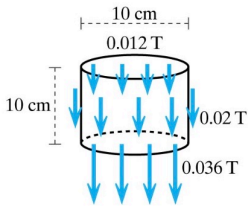
$$= 2.301 e-12\ C$$



$$\sin(\theta) = \frac{0.04}{0.12}$$

$$\theta = 19.471^\circ$$

In the figure the magnetic field in a region is vertical and was measured to have the values shown on the surface of a cylinder. Which of the following are true?



- [x] The measurements are probably incorrect, since we have never yet found a magnetic monopole.
- [ ] The measurements imply that the box contains a bar magnet.
- [ ] The measurements imply that the box contains a current-carrying loop of wire.
- [ ] The measurements imply that the box contains nothing at all.
- [x] The magnetic flux over the closed box is nonzero, which violates Gauss's Law for magnetism.