Monday Jan 23, 2017

Labatorials start this week

- Check your schedule
- Print write-up
- Prepare
- Take advantage of the small group (24 not 200 students in the room) and group work (3-4)
- Checkpoints test your understanding
- Come on time (late arrival = group working without you = mark deduction)

Last time

- The electric field: conceptually difficult but much more useful
- TopHat questions related to direction of net E-field
- Finishing up Coloumb's Law: Group Activity

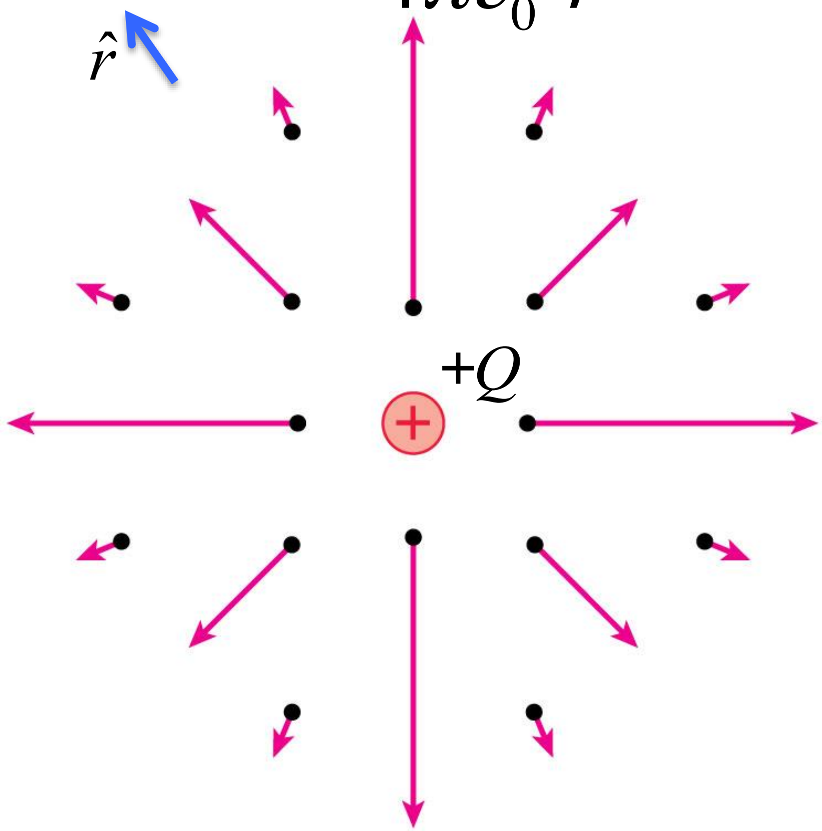
This time

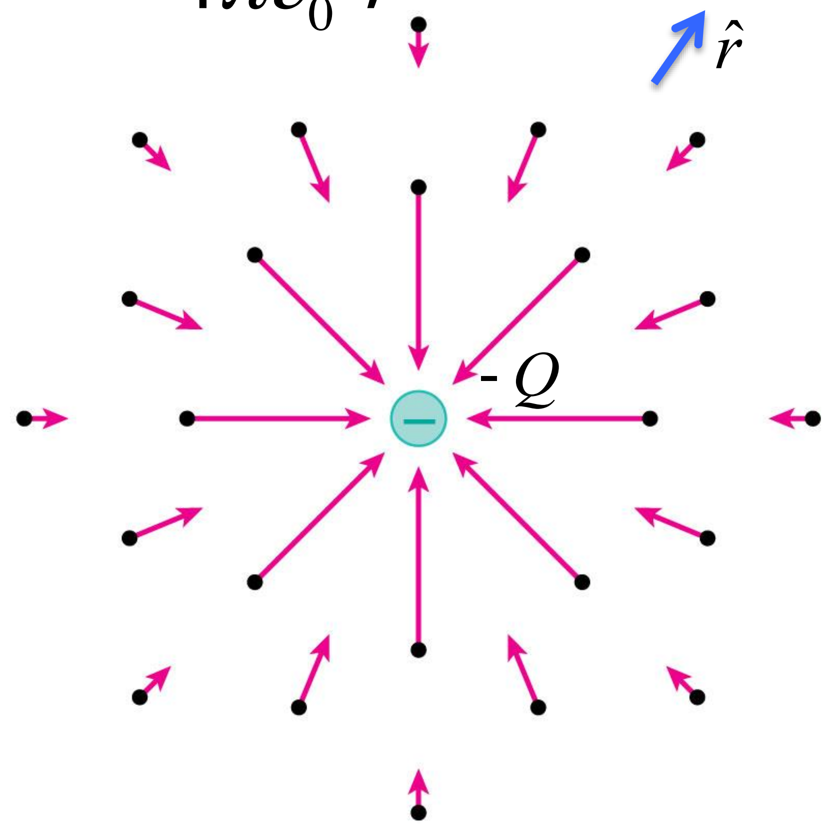
- More on electric fields: how to calculate them
- Example: electric field of a dipole.

Electric field of point charges

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}\hat{r}$$

$$\vec{E} = \frac{-1}{4\pi\varepsilon_0}\frac{Q}{r^2}\hat{r}$$





+ charge: $\vec{E}$ points away from Q

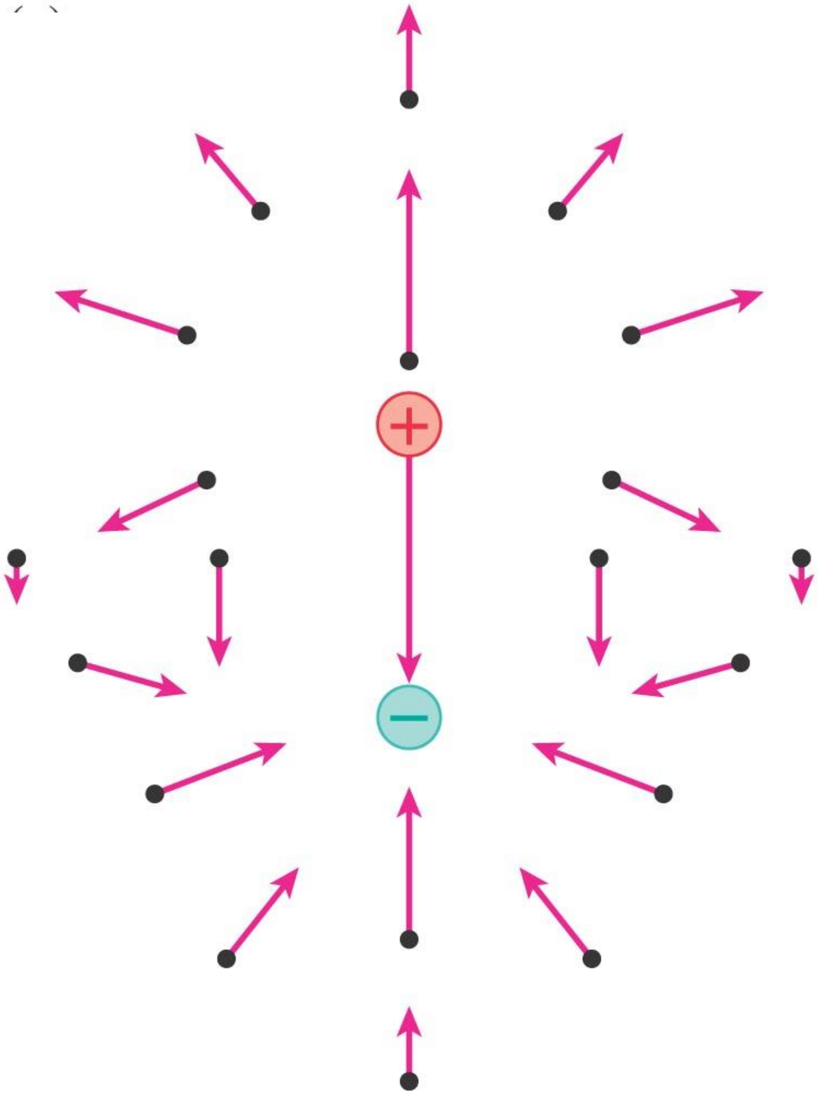
– charge: $\vec{E}$ points toward –Q

Electric Field Vectors

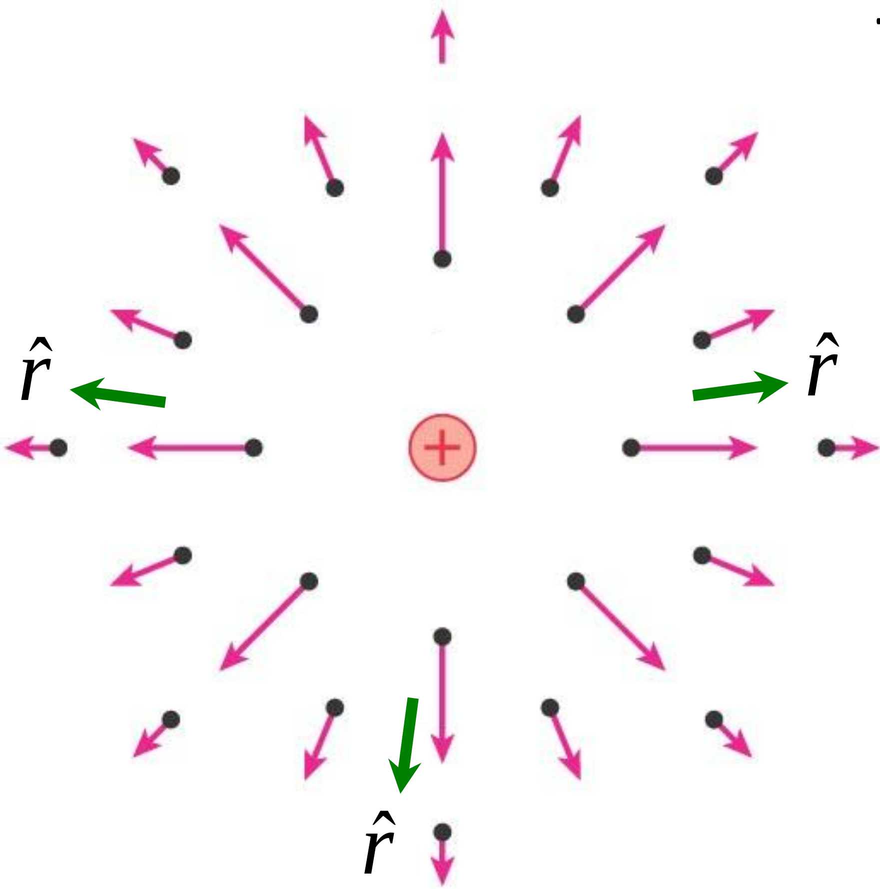
The vector represents the magnitude and direction of the electric field **at that point**.

But $\vec{E}$ is not a spatial quantity that stretches from one end of the arrow to the other.

Instead, think of $\vec{E}$ as a spatial quantity at every point with a direction at that point given by the arrow.



Electric Field building blocks



The electric field around a **point charge, q,** is given by

$$\boxed{\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r}}$$

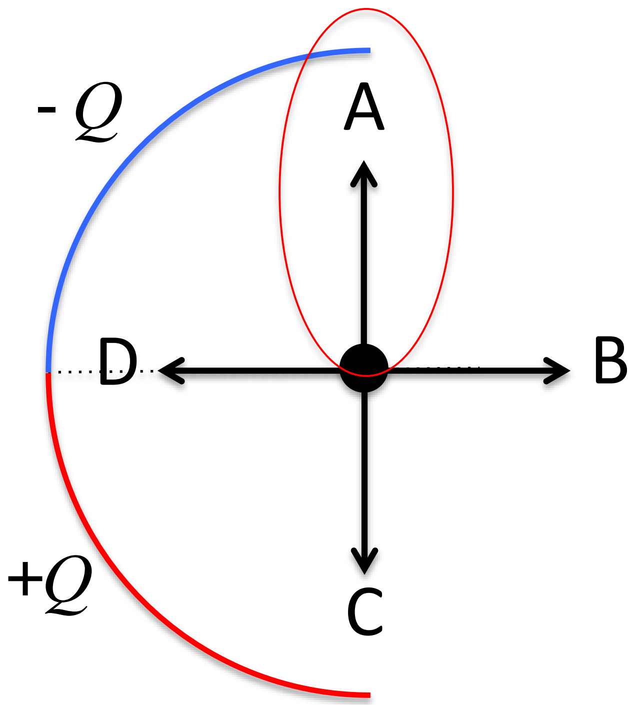
$\hat{r}$ is a **unit vector** that always points **away from** q.

We can use this with superposition to find the electric field of more complicated objects.

TopHat Questions

TopHat Question

What is the direction of the electric field at the point indicated?



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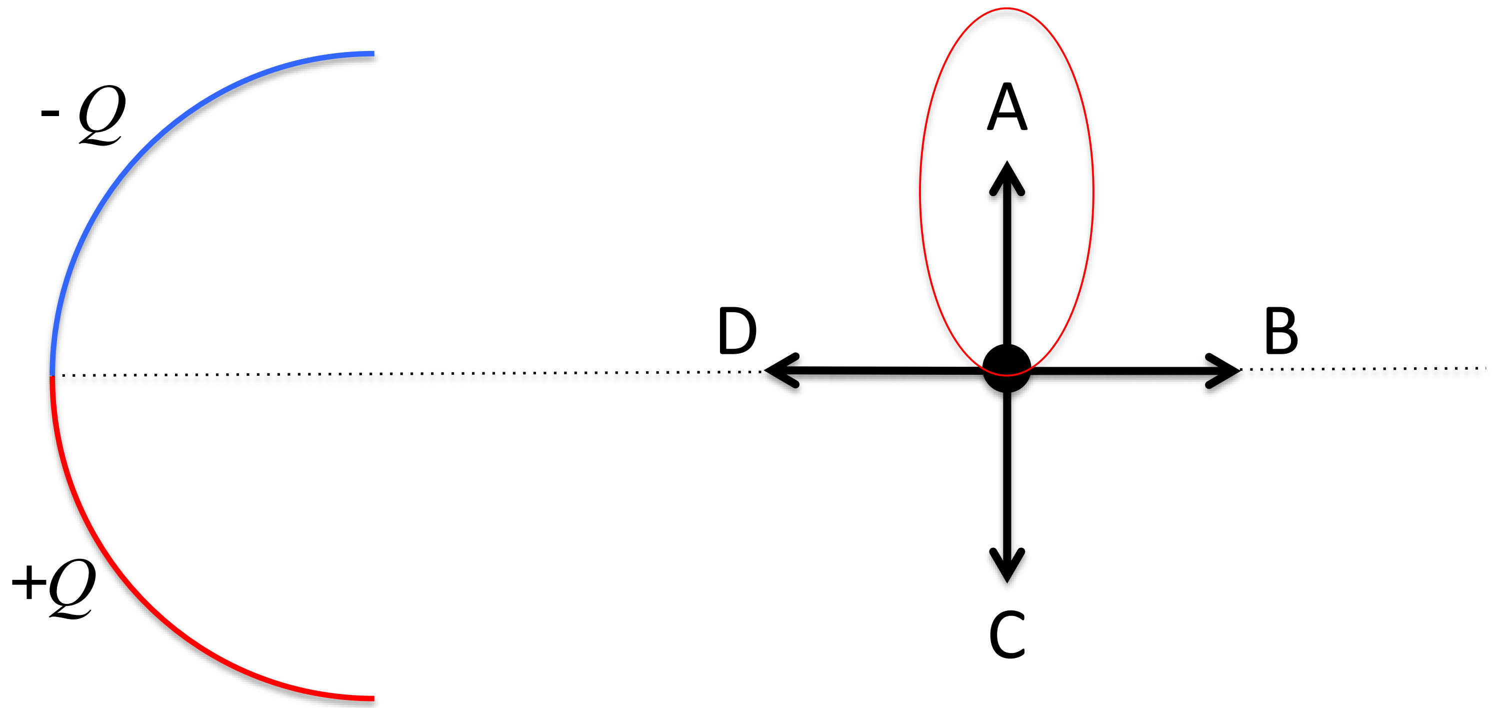

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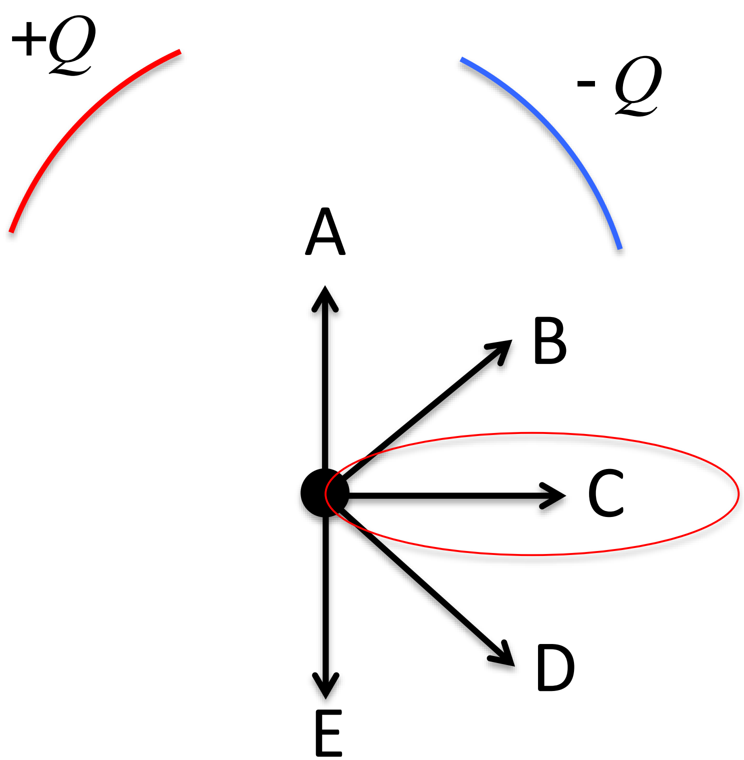
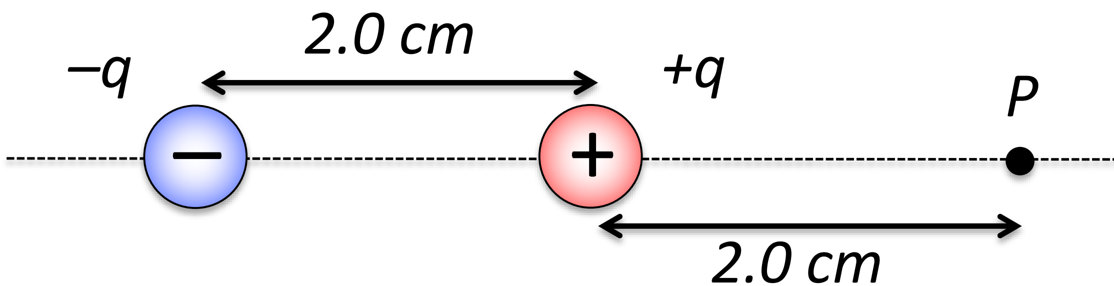


TopHat Question

An electric dipole: if the electric field strength at point P is E = 6068 N/C, what is the charge q?



For single point charge:

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$$

$$\varepsilon_0 = 8.85\text{x}10^{-12}\ \mathrm{C^2/N\cdot m^2}$$

A. 0.36 nC

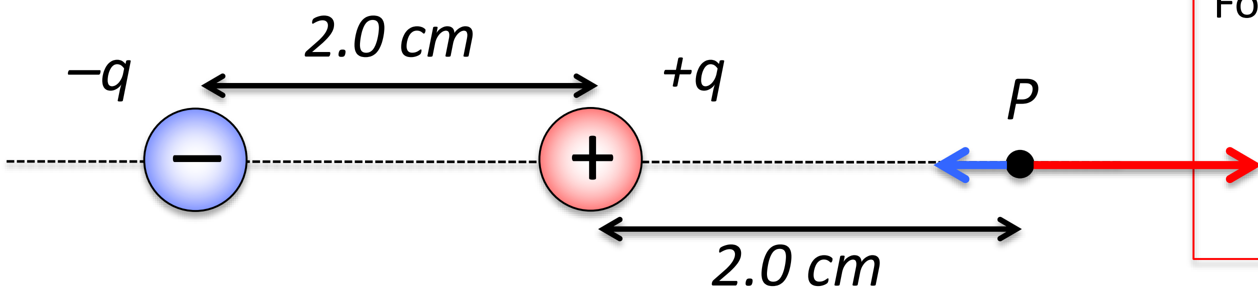
B. 0.27 nC

C. 0.22 nC

D. 0.13 nC

TopHat Question Feedback

An electric dipole: if the electric field strength at point P is E = 6068 N/C, what is the charge q?



For single point charge:

$$E = \frac{1}{4pe_0}\frac{q}{r^2}$$

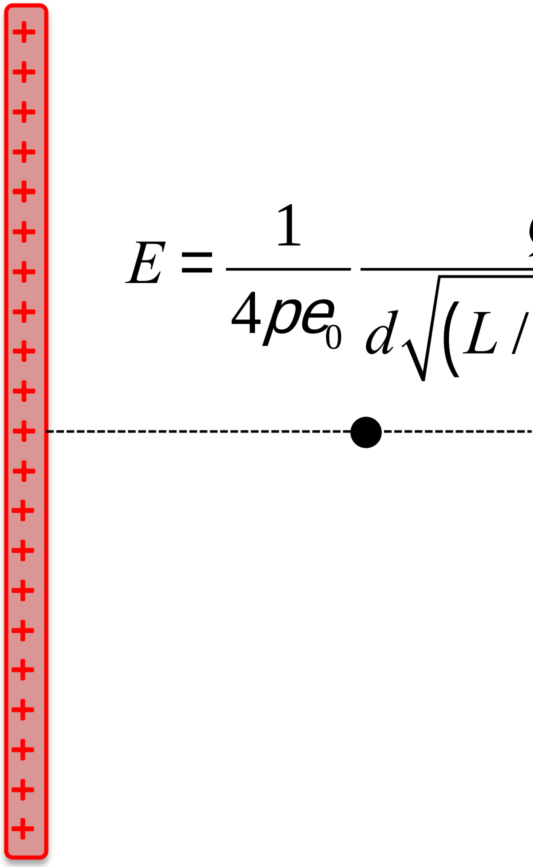
$$\varepsilon_0 = 8.85\text{x}10^{-12}\ \mathrm{C^2/N \cdot m^2}$$

$$E_+ = \frac{1}{4pe_0}\frac{q}{r_+^2} \qquad E_- = -\frac{1}{4pe_0}\frac{q}{(2r_+)^2}$$

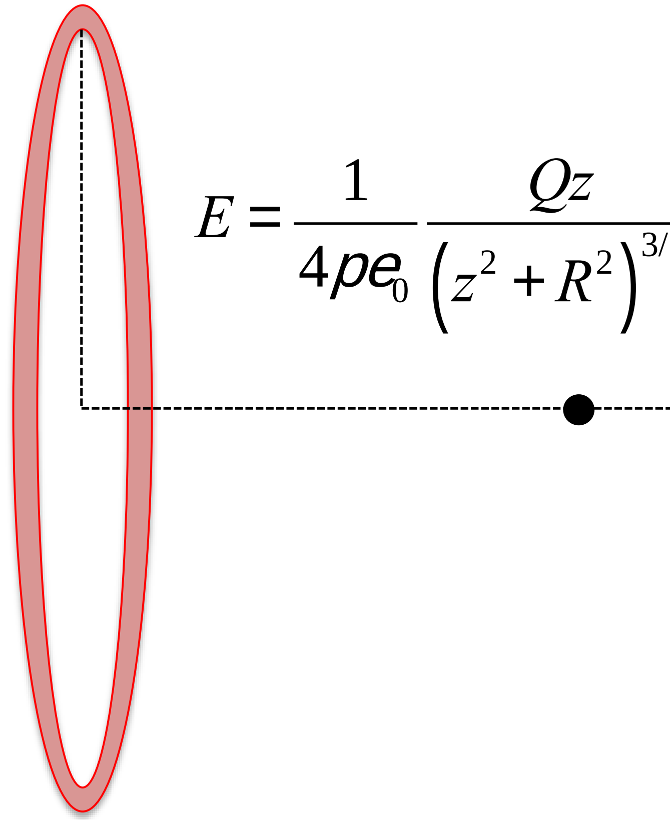
$$E_{net} = \frac{1}{4\pi\varepsilon_0} q\left(\frac{1}{{r_+}^2} - \frac{1}{4{r_+}^2}\right) = \frac{1}{4\pi\varepsilon_0}\frac{3q}{4{r_+}^2}$$

$$\boxed{q = 4pe_0 \frac{4r_+^2 E_{net}}{3}}$$

Cases we've already seen



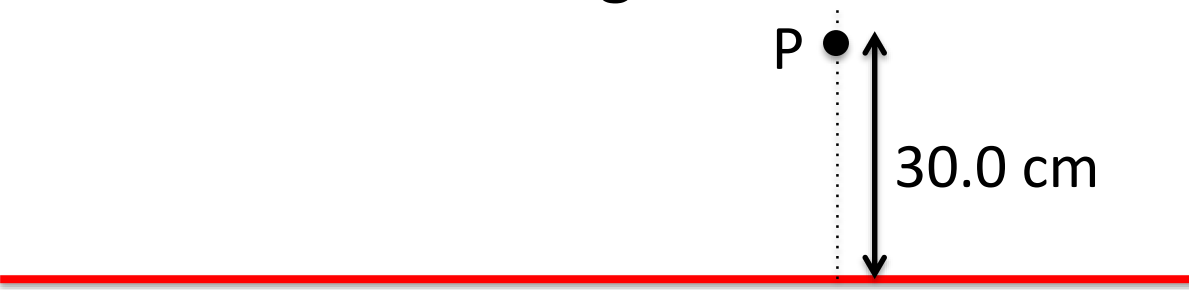
$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{d\sqrt{(L/2)^2 + d^2}}$$



$$E = \frac{1}{4\pi\varepsilon_0}\frac{Qz}{\left(z^2 + R^2\right)^{3/2}}$$

TopHat Question

An infinitely long wire: if the electric field strength at point P is E = 3670 N/C, how much charge is contained in a 0.500 m length of the wire?



$$E_{wire} = \frac{1}{4\pi\varepsilon_0}\frac{2\lambda}{r}$$

$$\varepsilon_0 = 8.85\text{x}10^{-12}\ \text{C}^2/\text{N}\cdot\text{m}^2$$

A. 18.37 nC

B. 30.62 nC

C. 61.23 nC

D. 9.19 nC

TopHat Question Feedback

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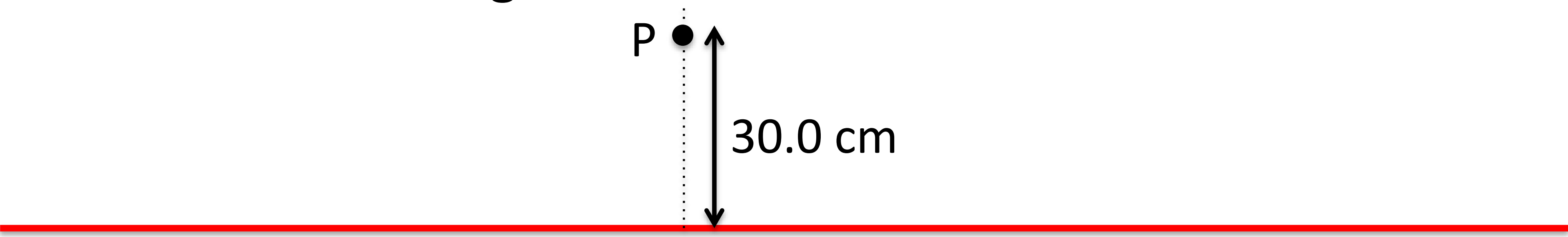
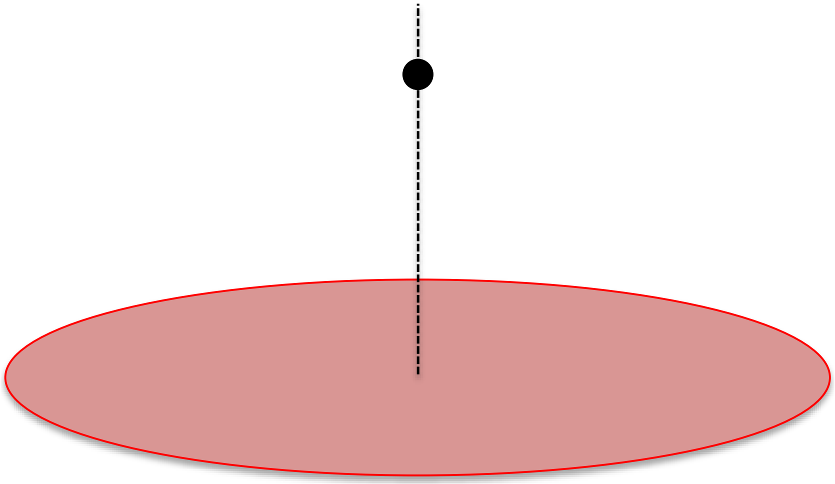


$$\varepsilon_0 = 8.85\text{x}10^{-12}\ \mathrm{C^2/N \cdot m^2}$$

$$E_{wire} = \frac{1}{4\pi\varepsilon_0}\frac{2\lambda}{r} \qquad E_{wire} = \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}$$

$$\lambda = 2\pi\varepsilon_0 E_{wire} r \qquad / = \frac{\Delta Q}{\Delta L} \qquad Q = \lambda L$$

Charged disk



$$E = \frac{\sigma}{2\varepsilon_0}\left[1 - \frac{z}{\sqrt{z^2 + R^2}}\right]$$