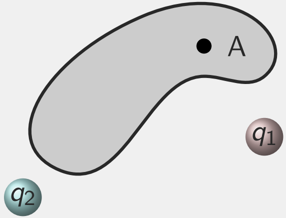
Announcements

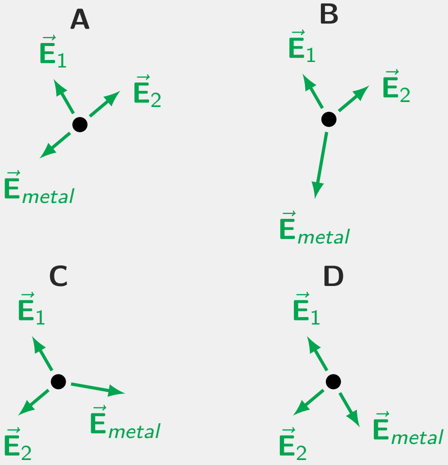
- Homework
  - Online Homework 5 due tonight
  - A new video homework due Monday
- Physics Tea today at 3pm!
- Polling: `rembold-class.ddns.net`

Review Question!

Location A lies within a neutral, solid piece of metal which has been placed near two point charges. Which diagram to the right shows the proper Electric field vectors due to:

- Charge q_1
- Charge q_2
- The surface charge on the metal





Van-der-Graff Demos

What we'd like to understand:

- How do objects interact or behave near the generator?
- Why can we not neutralize the generator?
- How does a Van-der-Graff generator work?
- What happens when a spark jumps through air?

Charges Example 1

Two metal boxes with equal dimensions are sitting next to one another but not touching. $6\,\mu C$ of charge is placed onto one box. The boxes are then moved so they are touching, and then separated again. How much charge is on each box?

Example 2

Now say three metal boxes with equal dimensions are sitting next to one another but not touching. $6\,\mu\mathrm{C}$ of charge is placed onto one box. The boxes are then moved so they are touching, and then separated again. How much charge is on each box?

Example 3

Two metal boxes with equal dimensions are sitting next to one another but not touching. The boxes are then moved so they are touching, and then a 10 mC charge is brought near the left box but does *not* touch it. The boxes are separated, and then the charge is removed. What is the net charge on each box?

Understanding Check

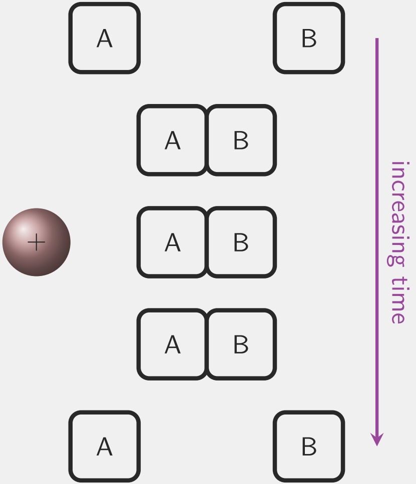
Consider the sequence of events to the right. Both blocks are neutral conductors initially. What is the net charge on block A at the conclusion?

A. Positive

B. Negative

C. Neutral

D. None of the above



Upcoming:

Electric Field from Distributions

The Game Plan

- We know the electric field due to a point charge
- We know that superposition holds for multiple charges
- Want to use that to build up electric field from charge distributions
- The plan of attack:
  A. Break our distribution up into pieces
  B. Determine the E-field due to one piece
  C. Add up the contributions from all the pieces
  D. Check to make sure we haven't messed up royally

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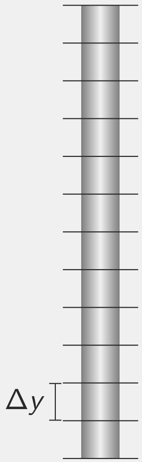

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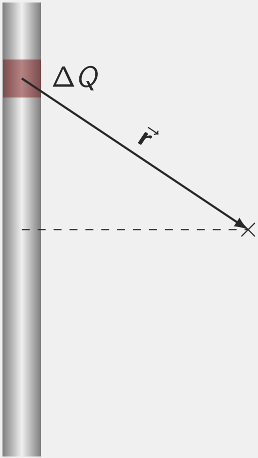

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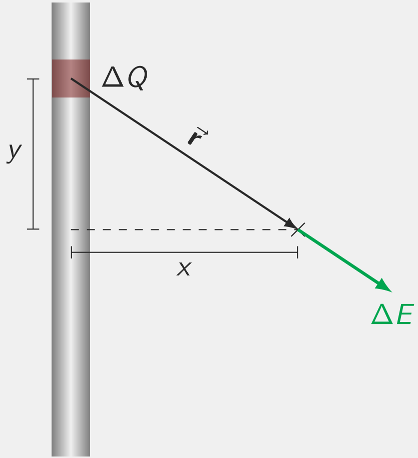
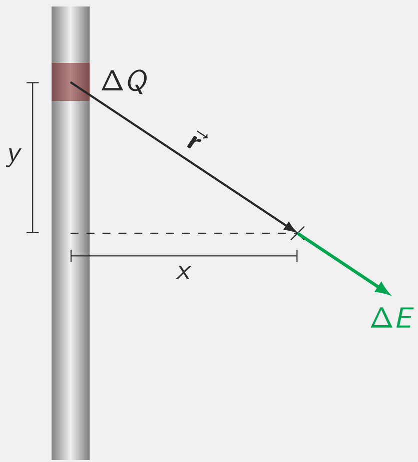


Uniformly Charged Rod: Step 2



Now to determine the electric field due to our ΔQ:

- Determine $\vec{\mathbf{r}}$:

$$\vec{\mathbf{r}} = \langle x, -y, 0 \rangle$$

- Find the magnitude and $\hat{\mathbf{r}}$:

$$|\vec{\mathbf{r}}| = \sqrt{x^2 + y^2}, \quad \hat{\mathbf{r}} = \frac{\langle x, -y, 0 \rangle}{\sqrt{x^2 + y^2}}$$

- Write out the E-field:

$$\Delta \vec{\mathbf{E}} = \frac{1}{4\pi\epsilon_0} \frac{\Delta Q}{\sqrt{x^2 + y^2}} \frac{\langle x, -y, 0 \rangle}{\sqrt{x^2 + y^2}}$$

Uniformly Charged Rod: Step 3

- Can break into components:

$$\Delta E_x = \frac{1}{4\pi\epsilon_0}\frac{x\Delta Q}{(x^2+y^2)^{3/2}}$$
$$\Delta E_y = \frac{1}{4\pi\epsilon_0}\frac{-y\Delta Q}{(x^2+y^2)^{3/2}}$$

- To get total electric fields (not Δ), we need to sum over the different segments (superposition ftw!)
- Can be useful to write:

$$\frac{\Delta Q}{\Delta y} = \frac{Q}{L} \quad \Rightarrow \quad \Delta Q = \frac{\Delta y}{L} Q$$

y	ΔE_x	ΔE_y
−0.45	0.92	4.13
−0.35	1.87	6.53
−0.25	4.61	11.53
−0.15	15.36	23.04
−0.05	64.4	32.2
0.05	64.4	−32.2
0.15	15.36	−23.04
0.25	4.61	−11.53
0.35	1.87	−6.53
0.45	0.92	−4.13

Number of Divisions