

① Phys 1401 2015-09-01 Lec 2

A 0.5 g styrofoam bead has a charge of +50 nC. What is the charge of just the electrons?

- Protons $m_p = \frac{1.67 \times 10^{-27}}{1.67 \times 10^{-19}} \text{ kg}$ $q = +e$
- Neutrons $m_n = m_p$ $q = 0$
- Electrons $m_e = 9.11 \times 10^{-31} \text{ kg}$ $q = -e$

$$e = 1.6 \times 10^{-19} \text{ C}$$

Most matter has roughly $N_p = N_n = N_e$

$$\text{For our bead } N_p = \frac{(0.25 \times 10^{-3} \text{ kg})}{(1.67 \times 10^{-27} \text{ kg})}$$

$$= 1.5 \times 10^{23} \text{ protons}$$

$$\begin{aligned} \Sigma q_p &= N_p e = (1.5 \times 10^{23})(1.6 \times 10^{-19} \text{ C}) \\ &= 24000 \text{ C} \end{aligned}$$

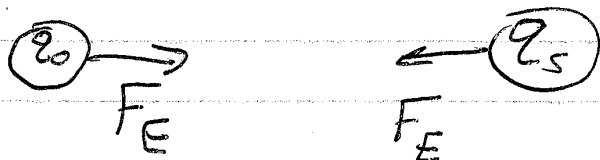
$$\begin{aligned} \Sigma q_e &= -23999.99999995 \text{ C} \\ &\approx -24000 \text{ C} \end{aligned}$$

②

Model 1: Coulomb's Law

For our object, 0:

$$F_E = k \frac{q_0 q_s}{r^2}$$



(Drawn as attractive)

Model 2: Electric Field

$$F_E = q_0 E \quad E = \text{caused by source(s)}$$

Ex: Electrostatic levitation
(Obj. is stationary even w/ gravity)

A diagram showing a circle labeled m . An upward-pointing arrow is labeled $F_E = 0.0049 \text{ N}$. A downward-pointing arrow is labeled F_g .

$$E = \frac{F_E}{q} = \frac{0.0049 \text{ N}}{50 \times 10^{-9} \text{ C}} = 9.8 \times 10^4 \text{ N/C}$$

$$\downarrow F_g = mg = (0.5 \times 10^{-3} \text{ kg})(9.8 \text{ N/kg}) = 0.0049 \text{ N}$$

Max E in air is $\sim 3 \times 10^6 \text{ N/C}$

Try to exceed \rightarrow sparks, lightning

③

Sources of E-Field

- Point Source, charge = q

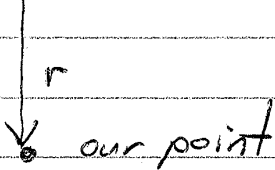
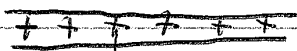
$$E = \frac{kq}{r^2}$$

- \vec{E} points in dir of \vec{F}_E on a $+q_0$
- points away from a $+q_s$
- points toward a $-q_s$

PhET simulation (Lab 1)

E is in $N/C = V/m$

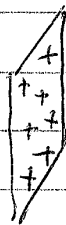
- Line charge: $\lambda = q/l = \text{charge per length}$



$$E = 2k \frac{\lambda}{r}$$

$$k = 9 \times 10^9 \frac{Nm^2}{C^2}$$

- Surface Charge: $\sigma = q/A$



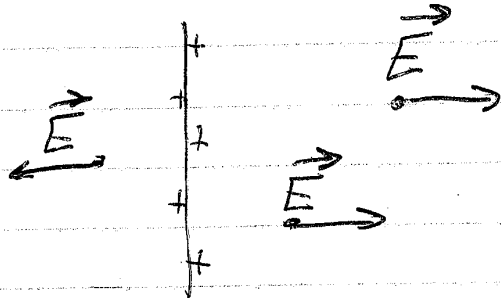
•
our point

$$E = 2\pi k \sigma$$

• is "uniform"

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One surface charge



$$\sigma = 50 \text{ nC/m}^2$$

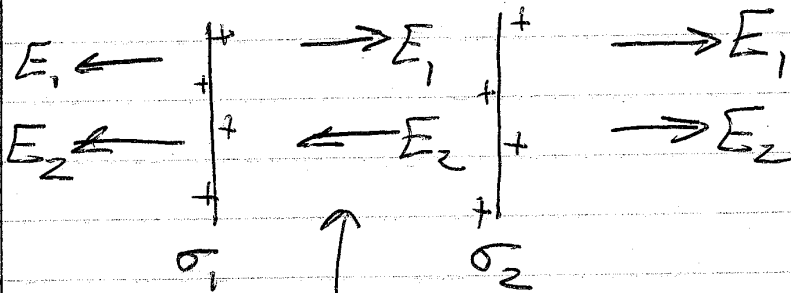
$$E = 2\pi k \sigma$$

$$= 2\pi (9 \times 10^9 \text{ N}) (50 \times 10^{-9} \text{ C/m}^2)^2$$

$$= 2800 \text{ N/C}$$

Sphere w/ area $1 \text{ m}^2 = 4\pi r^2$
 radius = 0.282 m

Two surface charges magnitude



$$E_T = 0 \text{ if } \sigma_1 = \sigma_2$$

On either side

$$E_T = 5600 \text{ N/C}$$

This object is a piece of metal w/
 Total $\sigma = 100 \text{ nC/m}^2$
 split evenly on each side.
 $E = 0$ in the metal.

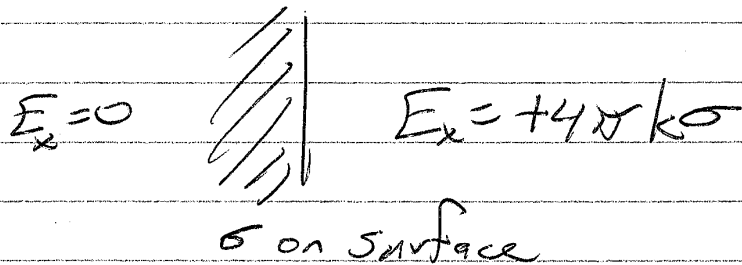
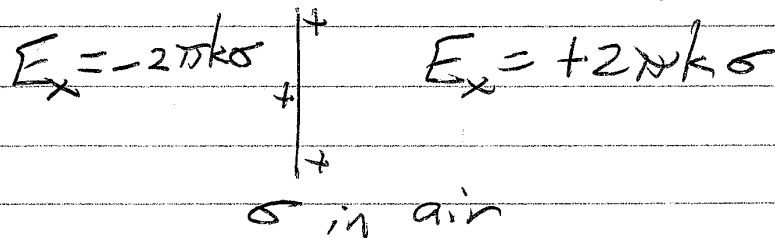


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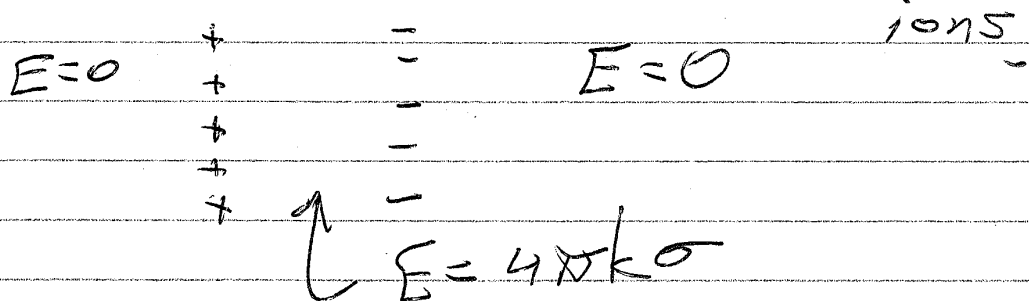
Metal Surface

- $E=0$ inside
- $E=4\pi k\sigma$ outside

Going through a surface charge makes E "step" by $4\pi k\sigma$.



Cell membrane creates E to push



Read: Chap 15
Up to 16.3 on Thu