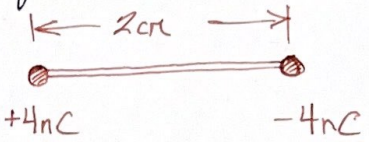
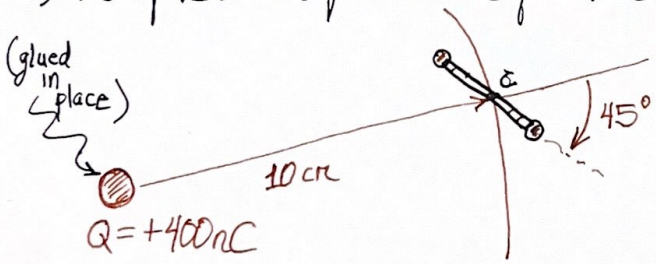
PHYSICS 123 — Week 2 Friday 28 Jan 2022

Question 1: Consider an electric dipole created by cementing 2 small charged (negligibly massive) spheres to the ends of a thin stick with mass 0.5g.



a) What is the tension in the rod? Is it under tension or compression?

b) The dipole is now placed in the presence of a 400nC as shown



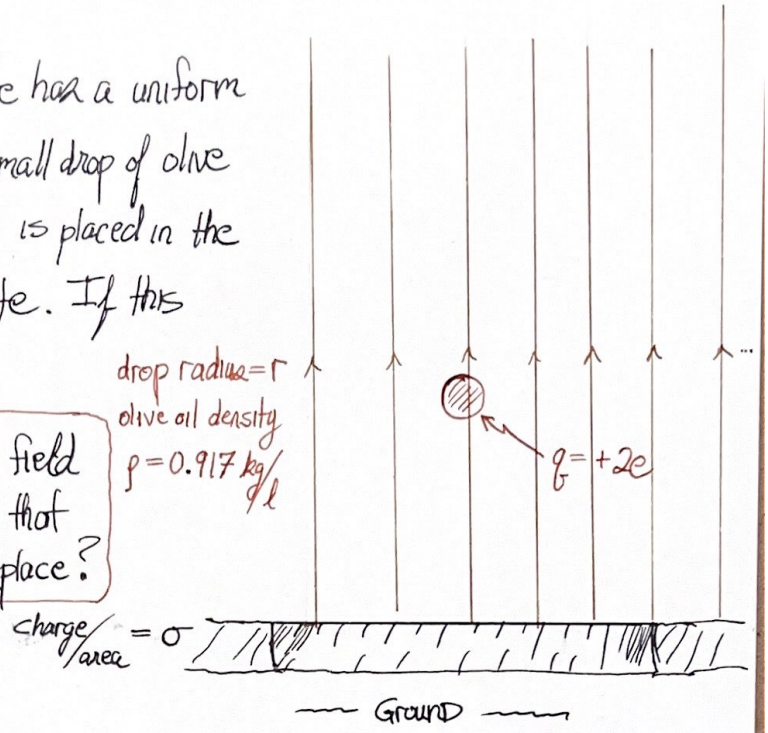
(i) What is the net force on the dipole?

extra for your Weekend Amusement → What is the net torque about the center of the dipole? (This is a little tricky, and I don't think you use $\vec{\tau} = \vec{p} \times \vec{E}$ for this ... do you see why?)

(ii) If released from rest, what will the acceleration of the dipole be?

Question 2: A charged plate has a uniform charge density $+\sigma$. A small drop of olive oil with radius $r = 4\,\mu m$ is placed in the electric field near the plate. If this drop has charge $+2e$,

How large is the electric field created by the plate so that the sphere is levitated in place?



Question 3 Sit next to someone in the room. Now imagine that suddenly, you each acquired a $\frac{1}{100}$ % excess of electrons. What size would the repulsive force be that you'd each feel if you sat 2,0 m apart?

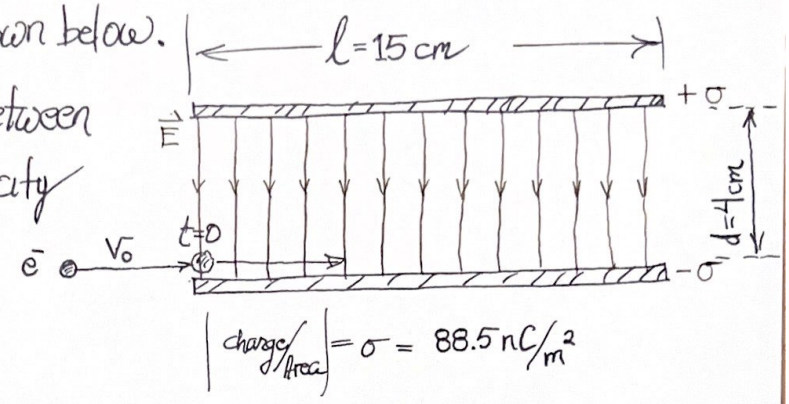
(you'll have to make some pretty rough approximations in this to determine a rough estimate for how many electrons we each have in our bodies.)

Question 4

A particle deflector is shown below. An electron enters the region between the plates with an initial velocity

$\vec{V} = V_0 \hat{i} = 2 \times 10^6 \frac{m}{s} \hat{i}$

as shown.



(i) how long will it be until the electron leaves the region between the plates? (What is the path taken by the electron? What can you say about where it exits the plates?) ← just roughly, not asking for a computation ... NOT yet, anyway ...

(ii) When the electron enters the field, it will feel an electric force $\vec{F}$. Compute this force.

(iii) What will the acceleration of the electron be?

Question 4 continued...

(iv) Now compute where the electron either

a) Smashes into one of the plates, or

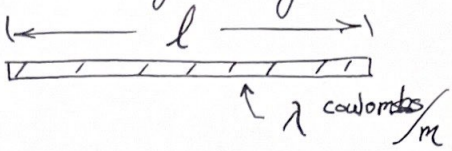
b) successfully exits the plates.

In either case, (you have to convince me ~~either~~ whether (a) or (b) is what occurs)

Compute ① where it either smashes or exits

② what its velocity vector components are before smash/or exit.

Question 5 A thin stick with uniform linear charge density λ, and length l is shown below.

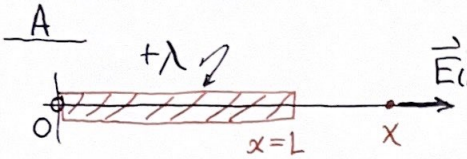


In class we computed the Electric field such a stick would create at

(A) A point on the axis along the length of the stick AND some distance from the far end of the stick.

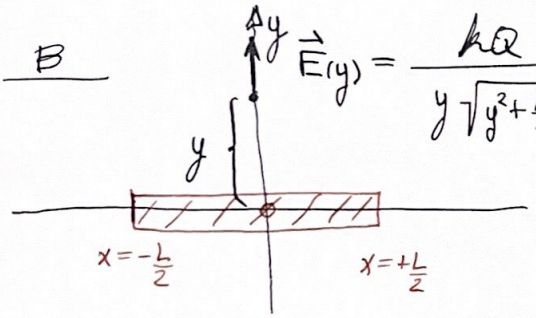
(B) A point at a distance y above the center of stick along the $\perp$ bisector of the stick.

A



$$\vec{E}(x) = \frac{kQ}{x(x-L)}\hat{i}$$

B



$$\vec{E}(y) = \frac{kQ}{y\sqrt{y^2+\frac{L^2}{4}}}$$

For each case, convince me that the electric fied far from each stick approaches a physically understandable limit. Explain your thinking..