General Physics - E&M (PHY 1308) Lecture Notes

Quiz004

SteveSekula, 17 September 2010 (created 15 September 2010)

no tags

Name:_____

Date:_____

Rules for the Quiz:

- You are given **5 minutes at the beginning** to look over the quiz quietly and jot some notes on a 3x5-inch notecard. Use this time to think about how to attack the quiz problem(s)
- You are given **10 minutes in the middle** to discuss the quiz with your teammates. Use this time to develop strategies across the group for attacking the problem(s). You are allowed to keep notes from this discussion on the SAME 3x5-inch notecard.
- You then have **15 minutes at the end** to work individually (NO MORE DISCUSSION) to solve the problem(s). Use your notes on the 3x5-inch card to help you attack the problem(s)
- You are allowed to use a calculator
- Your grade will be determined from the weighted-average of your group and not from your individual performance. The highest grade will be weighted the most, and the lowest the least. Low grades will drag the average down, so it is in your best interest to collaborate during the discussion part of this quiz. All members of your team get the same grade, determined from that weighted average.

DNA electrophoresis uses an electric field to separate genes in a DNA sample. The amount of separation of different sized genes can be used as a "DNA Fingerprint".

Consider such a setup, illustrated below. The source of the electric field in the setup is a negatively charged plate at the bottom of the device. Genes carry net negative charge, and are repelled by the negative charge on the

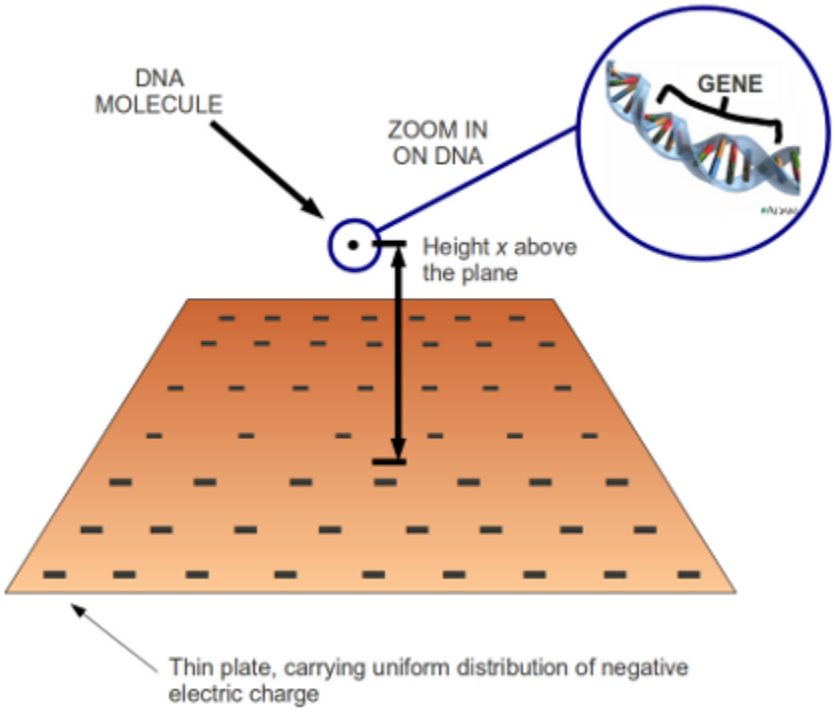
plate. Genes come in different sizes (and thus different masses and charges) and move at different speeds in response to the electric field. Compared to the plate, however, genes are extremely tiny and from their perspective the plate extends infinitely in its plane.

(1) *(20 Points)* Treat the plate as a very thin sheet of uniformly distributed positive charge. If you were asked to use Gauss's Law,

$$\int_{surface} \vec{E} \cdot d\vec{A} = q_{enclosed}/\epsilon_0,$$

to determine the electric field a height x above the plate . . .

- Based on the symmetry of the problem, draw 5 vectors representing the electric field $\vec{E}$ above the plate.
- Draw the Gaussian surface that you believe can be best used to solve the flux integral. *Explain why you chose this surface.*
- Draw 5 example vectors representing various $d\vec{A}$ at different locations on the surface.



(2) *(20 Points)* If a gene of electric charge $q = -3.4 \times 10^{-14}$C and mass $m = 6.0 \times 10^{-20}$kg is subjected to the electric field you drew above (whose

strength is $E = 1.0 \times 10^{-13}\,\mathrm{N/C}$), how long does it take for the gene to move $1.0\mathrm{cm}$? One or more of the formulas below may be useful.

$$v = v_0 + at$$

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$