Homework No. 02 (Fall 2021)

PHYS 205B: University Physics

Due date: Thursday, 2021 Sep 2, 9:30 AM, on D2L

Instructions

- Describe your thought process in detail and organize it clearly. Make sure your answer has the correct units and the right number of significant digits.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (under Assessments → Assignments).

Problems

1. (**10 points.**) Watch the following YouTube video by Bruce Yeany

   https://youtu.be/-csQiBHoucI

   to gain insight on how easy it is to charge styrofoam balls.

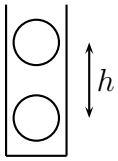

Figure 1: Two charged styrofoam balls trapped in a cylinder.

   Two identical styrofoam balls have a charge Q on each one of them. They are trapped inside a cylinder so that the electrostatic repulsion on the top ball from the bottom balances the gravitational force acting on it. Refer Figure 1. Assume that the walls of the cylinder does not exert any net vertical force on the top ball. Given that the balls weigh 0.040 grams each and the height $h = 1.0$ cm, determine the charge Q on each ball.

   Solution

2. (**10 points.**) Watch the following YouTube video by Science Marshall

   https://youtu.be/ysaUfsJyer0

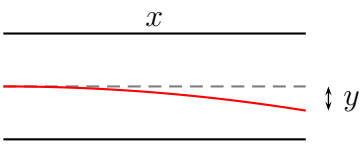

Figure 2: Deflection of an electron beam in a cathode ray tube.

on how a Cathode Ray Tube works.

The deflection plates of a cathode ray tube has an electric field of $1.0 \times 10^3\,\mathrm{N/C}$. Let the electron beam be aligned parallel to the plates. The electrons enter the plates with a speed of $4.0 \times 10^6\,\mathrm{m/s}$. The horizontal distance of the plates is $x = 5.0\,\mathrm{cm}$ and the beam gets deflected vertically by a distance y. Refer Figure 2.

(a) What is magnitude and direction of the acceleration experienced by an electron due to the electric field?

(b) How much time does an electron take to pass the distance x in the plates.

(c) Calculate the deflection y in centimeters.

Solution

3. (**10 points.**) Consider a region of uniform electric field

$$\vec{\mathbf{E}} = (1.0\,\hat{\mathbf{i}} + 2.0\,\hat{\mathbf{j}}) \times 10^3\,\frac{\mathrm{N}}{\mathrm{C}}. \tag{1}$$

Calculate the electric flux through a rectangular plane 0.40 m wide and 0.20 m long if the plane is parallel to the yz plane.

Solution

4. (**10 points.**) A charge of $105\,\mu\mathrm{C}$ is at the center of a cube of edge 75.0 cm. No other charges are nearby.

(a) Find the flux through each face of the cube.

(b) Find the flux through the whole surface of the cube.

(c) Would your answers to parts (a) or (b) change if the charge were not at the center?

Solution

5. (**10 points.**) The charge per unit length on an (infinitely) long, straight filament is $-88.5\,\mu\mathrm{C/m}$.

(a) Find the electric field 10.0 cm from the filament, where distances are measured perpendicular to the length of the filament. (Take radially inward toward the filament as the positive direction.)

(b) Find the electric field 21.0 cm from the filament, where distances are measured perpendicular to the length of the filament.

(c) Find the electric field 110 cm from the filament, where distances are measured perpendicular to the length of the filament.

Solution

6. (**10 points.**) A large, flat, horizontal sheet of dielectric material has a charge per unit area of $8.85\,\mu\text{C/m}^2$. Find the electric field just above and below the middle of the sheet.

Solution

7. (**10 points.**) A large, flat, horizontal sheet of conducting material has a charge per unit area of $8.85\,\mu\text{C/m}^2$. Find the electric field just above and below the middle of the sheet.

Solution

8. (**10 points.**) Consider a thin, spherical shell of radius 15.0 cm with a total charge of $32.2\,\mu\text{C}$ distributed uniformly on its surface.

(a) Find the electric field 10.0 cm from the center of the charge distribution.

(b) Find the electric field 22.0 cm from the center of the charge distribution.

Solution