Homework No. 02 (Spring 2022)

PHYS 203B-001: COLLEGE PHYSICS

Department of Physics, Southern Illinois University–Carbondale

Due date: Friday, 2022 Jan 28, 10:00am, on D2L

Instructions

- To the extent to which you depend on resources to complete this homework is a measure of how much extra work you need to put in to master the related concepts.
- 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 (Assesments → Assignments).

Problems

1. (**10 points.**) A positive charge $q_1 = 1.0\,\mu\text{C}$ is at the origin.

   (a) Determine the magnitude and direction of the electric field a distance 15 cm from the origin on the positive x axis. Then, determine the magnitude and direction of the force experienced by another positive charge $q_2 = 2.0\,\mu\text{C}$ placed at this position.

   (b) Determine the magnitude and direction of the electric field a distance 15 cm from the origin on the negative y axis. Then, determine the magnitude and direction of the force experienced by another positive charge $q_2 = 2.0\,\mu\text{C}$ placed at this position.

   Solution

2. (**10 points.**) Two charges, $q_1 = +1.0\,\mu\text{C}$ and $q_2 = -4.0\,\mu\text{C}$, are separated by a distance of 10.0 cm. See Fig. 1. Find the spot on the line where the net electric field is zero. Caution: This is not always in between the charges.

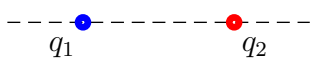

Figure 1: Problem 2.

Solution

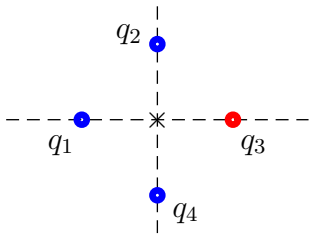

Figure 2: Problem 3

3. (**10 points.**) Figure 2 shows four charges, $q_1 = +1.0\,\mu\text{C}$, $q_2 = +2.0\,\mu\text{C}$, $q_3 = -3.0\,\mu\text{C}$, $q_4 = +2.0\,\mu\text{C}$, that are placed on the x and y axes. They are all located at the same distance of $L = 40.0\,\text{cm}$ from the origin marked as $\times$. Determine the magnitude and direction of the net electric field at the origin. Then, determine the magnitude and direction of the electric force experienced by another positive charge $q_5 = 5.0\,\mu\text{C}$ placed at the origin.

   Solution

4. (**10 points.**)

   (a) A uniformly charged (nonconducting) surface of infinite extent has a surface charge density of $1.8\,\text{nC/m}^2$. Determine the magnitude and direction of the electric field 15 cm above the surface.

   (b) A uniformly charged (conducting) surface of infinite extent has a surface charge density of $1.8\,\text{nC/m}^2$. Determine the magnitude and direction of the electric field 15 cm above the surface.

   (c) Two uniformly charged (conducting) parallel plates of infinite extent carry opposite surface charge densities of $1.8\,\text{nC/m}^2$. Determine the magnitude and direction of the electric field in the region between the plates.

   Solution

5. (**10 points.**)

   (a) Determine the acceleration of a ball of mass $m = 10.0\,\text{g}$ with a charge $q = 1.0\,\mu\text{C}$ in an electric field $E = 1000.0\,\text{N/C}$. Determine the acceleration of an electron in an electric field $E = 1000.0\,\text{N/C}$. Determine the acceleration of a proton in an electric field $E = 1000.0\,\text{N/C}$.

   (b) Starting from rest, determine the distance travelled by the ball, electron, and the proton, in the presence of this electric field in 1.0 ns.

   (c) Starting from rest, determine the speed attained by the ball, electron, and the proton, in the presence of this electric field in 1.0 ns.

Solution

6. (**10 points.**) An electron enters the region of a uniform electric field $E = 2.0 \times 10^3\,\mathrm{N/C}$

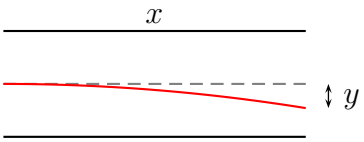

Figure 3: Problem 6

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 3. Calculate the deflection y in centimeters.

Solution to a related problem with a different number for electric field