# Homework No. 01 (Fall 2021)

## PHYS 205B: University Physics

Due date: Thursday, 2021 Aug 26, 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.**) Determine the number of protons in one nano-gram of protons. Then, calculate the total charge of one nano-gram of protons.
2. (**10 points.**) Two identical conducting spheres $A$ and $B$ carry equal charge. They are separated by a distance much larger than their diameters. A third identical conducting sphere $C$ is uncharged. Sphere $C$ is first touched to $A$, then to $B$, and finally removed.
   (a) As a result, what is the charge on $A$, if it was originally $Q$.
   (b) As a result, what is the charge on $B$, if it was originally $Q$.
   (c) As a result, what is the electrostatic force between $A$ and $B$, if it was originally $F$.
3. (**10 points.**) Three identical charges of equal magnitude $q$ are placed at the corners of an equilateral triangle of length $L$. Determine the magnitude of the Coulomb force on one of the charges.
4. (**10 points.**) Draw the electric field lines for a configuration consisting of two positive charges with unequal charge on them.
   (a) The direction of the electric field at a point in space is determined by the tangent to the electric field line passing through the point. What characteristic of the field lines represents the magnitude of the electric field?
   (b) Can two electric field lines intersect?
   (c) For this configuration, there are how many points where the electric field is zero.
5. (**10 points.**) Two charges, $q_1 = +1.00\,\mu\text{C}$ and $q_2 = -8.00\,\mu\text{C}$ are a distance $D$ apart. Refer Figure 1. As a multiple of distance $D$, at what coordinate $x$ on the line connecting the two charges is the total electric field zero?

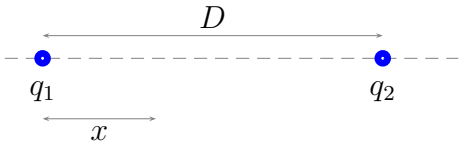


Figure 1: Problem 5

6. (**10 points.**) The electric dipole moment of a configuration consisting of two equal and opposite point charges, separated by a distance $d$, is defined to be

$$\vec{\mathbf{p}} = q\vec{\mathbf{d}}, \tag{1}$$

where $\vec{\mathbf{d}}$ points from the negative to the positive charge and $d = |\vec{\mathbf{d}}|$. Let $d = 2a$. Given $q = 1.0\,\mu\text{C}$, $d = 2.00\,\text{cm}$, and $y = 5.00\,\text{cm}$.

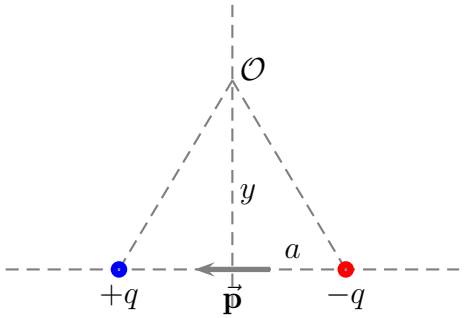


Figure 2: Problem 6

   (a) Determine the magnitude and direction of the electric dipole.

   (b) Determine magnitude and direction of the total electric field at $\mathcal{O}$ along a bisector of the electric dipole, a distance $y$ away from the center of the dipole.

   (c) Calculate the magnitude and direction of the force on a charge $Q = +7.0\,\mu\text{C}$ when placed at $\mathcal{O}$.

7. (**10 points.**) Consider a flat plate of infinite extent with a uniform surface charge density $\sigma$. Derive an expression for the magnitude and direction of the electric field due to this plate. In particular, inquire how the magnitude of electric field increases or decreases as you move farther away from the plate.

8. (**10 points.**) An electron and a proton are each placed at rest in a uniform electric field. The particles accelerate to respective speeds $v_e$ and $v_p$ after being released simultaneously. Determine the ratio $v_e/v_p$. Which of them gains higher speed? Which of them has a higher kinetic energy?