Homework No. 01 (Spring 2025)

PHYS 205B-002: UNIVERSITY PHYSICS

School of Physics and Applied Physics, Southern Illinois University–Carbondale

Due date: Tuesday, 2025 Jan 21, 4:00 PM, on D2L

Instructions

- You are encouraged to use any of the resources to complete this homework. However, the extent to which you depend on resources while doing this homework is a measure of how much extra work you need to put in to master the associated concepts. Solutions should be the last resource.
- Links to solutions are provided.
- Variations of homework problems and additional problems with hyperlinks to old exams are available in Lecture Notes. These serve as practice problems.
- Describe your thought process in detail and organize it clearly. Make sure your answer has units and right number of significant digits.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (under Assesments → Assignments). You can replace your PDF file as many times as you like, only the last file is graded. The deadline has an (undisclosed) buffer period, so do not hesitate to try submissions after the deadline.

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.

   Solution (Errata: At time 3:35 minutes it should read 9.58×10^{-5} C. The answer, in the line following this error, is correct.)

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.

   Solution

3. (**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. Two identical styrofoam balls

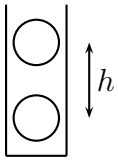

Figure 1: Two charged styrofoam balls trapped in a cylinder.

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 $h = 1.0\,\text{cm}$, determine the charge Q on each ball.

Solution

4. (**10 points.**) Three charges $q_1 = +q$, $q_2 = +q$, and $q_3 = -q$, with $q = 1.0\,\text{nC}$, are placed at the corners of an equilateral triangle of side $L = 3.0\,\text{cm}$. Refer Figure 2. Calculate the magnitude and direction of the total electric force on charge q_2.

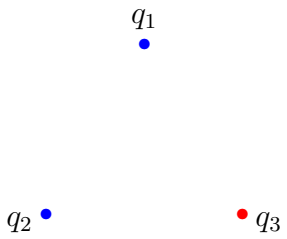

Figure 2: Problem 4

Solution

5. (**10 points.**) Three charges $q_1 = +q$, $q_2 = +q$, and $q_3 = -q$, with $q = 1.0\,\text{nC}$, are placed at three corners of a square of side $L = 3.0\,\text{cm}$, such that q_2 and q_3 are at diagonally opposite corners. Refer Figure 3. Calculate the magnitude and direction of the total electric force on charge q_2.

Solution

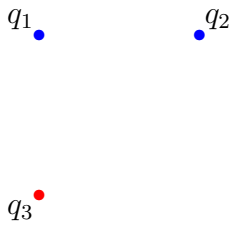

Figure 3: Problem 5

6. (**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.

   Solution

7. (**10 points.**) Four identical charges of equal magnitude q are placed at the corners of a square of side L. Determine the magnitude of the Coulomb force on one of the charges.

   [**Solution01**, **Solution02**]