# Midterm Exam 01 (2022 Spring)

## PHYS 203B-001: College Physics

Date: 2022 Feb 7

(Name) (Signature)

## Instructions

1. Seating direction: Please be seated on seats with seat numbers divisible by 4.
2. Total time = 50 minutes.
3. There are 8 questions in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to show your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. (**5 points.**) Three identical conducting spheres $A$, $B$, and $C$, carry charges $Q$, $2Q$, and $3Q$, respectively.. They are separated by a distance much larger than their diameters. Sphere $C$ is first touched to $A$, then to $B$, and finally removed. As a result, what is the charge on $B$.

2. (**5 points.**) Electric field lines is a visual representation of the magnitude and direction of the electric field due to a configuration of charges. Draw the electric field lines due to two negative charges of equal magnitude separated by 4.0 cm. Points will be awarded for clarity and accuracy.

3. (**5 points.**) What is the electric field at the center of a uniformly charged spherical shell of radius $R$ carrying a total charge $Q$ on the surface.

4. (**10 points.**) Fig. 1 shows three point charges that lie in the $x$-$y$ plane. Given $q_1 = -4.0\,\mu\text{C}$, $q_2 = +6.0\,\mu\text{C}$, $q_3 = +5.0\,\mu\text{C}$, charges $q_1$ and $q_2$ are separated by a distance of 4.0 cm, and charges $q_1$ and $q_3$ are separated by a distance of 6.0 cm. Find the magnitude and direction of the net electrostatic force on charge $q_1$.

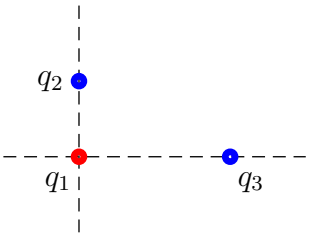


Figure 1: Problem 4

5. (**10 points.**) Two electrons and two protons are placed at the corners of a square of length $L = 4.0\,\text{cm}$ such that the electrons are at diagonally opposite ends.. Determine the magnitude and direction of the electric field at the center of the square.

6. (**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. 2. Find the spot on the line where the net electric field is zero.

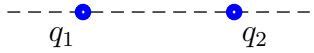


Figure 2: Problem 6.

7. (**10 points.**) A proton and an electron are moving due East in a uniform electric field that also points due East. Determine the ratio of the magnitude of the acceleration of the electron $a_e$ and that of the proton $a_p$,

$$\frac{a_e}{a_p}. \tag{1}$$

8. (**10 points.**) A point charge $Q = +1.0\,\mu\text{C}$ sits at the center of a charged spherical shell of radius $R = 4.0\,\text{cm}$ with charge $Q' = -2.0\,\mu\text{C}$ uniformly distributed on its surface. Using Gauss's law find the total electric flux across a spherical shell enclosing the shell.