Midterm Exam 01 (2015 Fall)

PHYS 203B: College Physics

Date: 2015 Sep 17

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 3.
2. Total time = 75 minutes.
3. There are 10 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. (**10 points.**) A hydrogen atom consists of an electron orbiting a proton. Determine the ratio of the gravitational force and the electrostatic force. (The radius of the hydrogen atom is about $5.3 \times 10^{-11}\,\mathrm{m}$, which is in principle not necessary for this evaluation.)

2. (**10 points.**) Two identical metallic objects carry the following charges: $+2.0\,\mu$C, and $-8.0\,\mu$C. The objects are brought simultaneously into contact, so that they touch each other. Determine the Coulomb force between the objects after they are separated by a distance 10.0 cm.

3. (**10 points.**) Fig. 1 shows three point charges that lie in the x-y plane. Given $q_1 = -5.0\,\mu\text{C}$, $q_2 = +4.0\,\mu\text{C}$, $q_3 = -6.0\,\mu\text{C}$, 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.

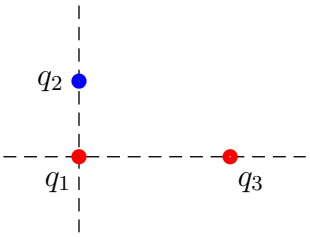

Figure 1: Problem 3

4. (**10 points.**) The drawing 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.

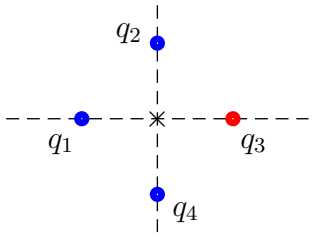

Figure 2: Problem 4

5. (**10 points.**) Two charges, $q_1 = +8.0\,\mu\text{C}$ and $q_2 = -2.0\,\mu\text{C}$, are separated by a distance of 1.0 m. See Fig. 3. Find the spot on the line between the charges where the net electric field is zero.

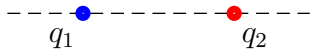

Figure 3: Problem 5

6. (**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,

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

7. (**10 points.**) A proton is released from rest in a uniform electric field of $E = 4.0\times10^3\,\mathrm{N/C}$. Determine the distance travelled by the proton in one nanosecond.

8. (**10 points.**) The drawing shows an edge-on view of a planar surface of area $2.0\,\mathrm{m}^2$. Given $\theta = 30°$. The electric field vector $\vec{\mathbf{E}}$ in the drawing is uniform and has a magnitude of $3.0 \times 10^2\,\mathrm{N/C}$.
Caution: Note that area is a vector.

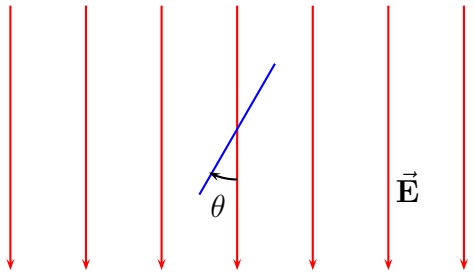

Figure 4: Problem 8.

9. (**10 points.**) An electron is placed at the center of a neutral spherical shell. Determine the electric flux through the surface of the spherical shell.

10. (**10 points.**) Consider a perfectly conducting sphere of radius $R = 7.0\,\text{cm}$ with charge $Q = 1.0\,\mu\text{C}$. Determine the electric flux through the surface of a (Gaussian) sphere of radius 5.0 cm, concentric with respect to the conducting sphere.