Midterm Exam No. 01 (2017 Spring)

PHYS 205B: University Physics

Date: 2017 Feb 9

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 4.
2. Total time = 75 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. (**10 points.**) A hydrogen atom consists of a proton and an electron. Find the ratio of the electrostatic force to that of the gravitational force between the proton and electron in the hydrogen atom. (You do not need the knowledge of the radius of the hydrogen atom for this calculation.)

2. (**10 points.**) Two positive charges and two negative charges of magnitude Q are placed at the corners of a square of length L such that like charges are at diagonally opposite corners. Determine the magnitude and direction of the force on one of the positive charges due to the other three charges.

3. (**10 points.**) See Figure 1. Two charges $q_1 = +2.0\,\mu\text{C}$ and $q_2 = -8.0\,\mu\text{C}$ are fixed to a line separated by a distance $d = 10.0\,\text{cm}$. At what point on the line is the electric field zero?

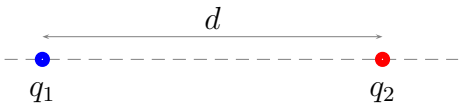

Figure 1: Problem 3.

4. (**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 in a fixed time after being released simultaneously. Determine the ratio v_e/v_p. Which of them gains higher speed?

5. (**10 points.**) Consider an infinite number of identical particles, each with charge q, placed along the x axis at distances a, $2a$, $3a$, $4a$, ... from the origin. What is the electric field at the origin due to this distribution? Suggestion: Use

$$1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \ldots = \frac{\pi^2}{6}. \tag{1}$$

6. (**10 points.**) What is the magnitude of the flux of the electric field,

$$\vec{\mathbf{E}} = \left[14\,\hat{\mathbf{i}} + 20\,\hat{\mathbf{j}} + 16\,\hat{\mathbf{k}}\right]\frac{\mathrm{N}}{\mathrm{C}}, \tag{2}$$

through a $2.0\,\mathrm{m}^2$ portion of the x-y plane?

7. (**10 points.**)

(a) Plot the electric field of a charged conducting solid sphere of radius R as a function of the radial distance r, $0 < r < \infty$, from the center.

(b) Plot the electric field of a uniformly charged non-conducting solid sphere of radius R as a function of the radial distance r, $0 < r < \infty$, from the center.

8. (**10 points.**) Two positive charges and two negative charges of equal magnitude are placed at the corners of a square of length L, such that like charges are at diagonally opposite corners. Determine the potential difference between the center of the square and the midpoint of either one of the sides of the square.