Midterm Exam No. 01 (2016 Spring)

PHYS 205B: University Physics

Date: 2016 Feb 18

(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 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.**) Two positive charges and two negative charges of equal magnitude Q are placed at the corners of a square of length L, such that like charges are at diagonally opposite corners.

   (a) Determine the magnitude of the force on one of the charges due to the other three.

   (b) Analyze the direction of the resultant force on one of the charges. If the four charges were free to move, will they collectively move away from each other or move towards each other?

2. (**10 points.**) Two identical positive charges of magnitude 1.0 nC are separated by a distance 2.00 cm. Determine the magnitude and direction of the electric field along the bisector, a distance $y = 2.50$ cm above the charges.

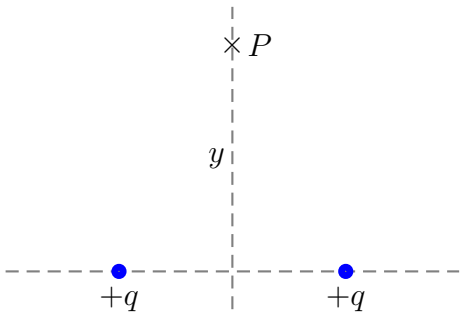

Figure 1: Problem 2.

3. (**10 points.**) See Figure 2. Two charges $q_1 = -4.0\,\mu\text{C}$ and $q_2 = -16.0\,\mu\text{C}$ 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?

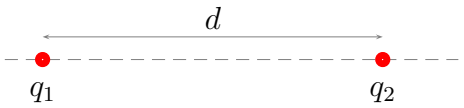

Figure 2: Problem 3.

4. (**10 points.**) A proton initially moves at $4.80 \times 10^5\,\mathrm{m/s}$ in the horizontal direction, say along $\hat{\mathbf{x}}$. It enters a uniform vertical electric field $\vec{\mathbf{E}} = -\hat{\mathbf{z}}\,8.80 \times 10^3\,\mathrm{N/C}$. Ignore any gravitational effects.

   (a) Find the time interval required for the proton to travel 4.50 cm horizontally.

   (b) Find its vertical displacement during the time interval in which it travels 4.50 cm horizontally. (Indicate direction with the sign of your answer.)

5. (**10 points.**) The drawing shows an edge-on view of a planar surface of area $2.0\,\mathrm{m}^2$. Given $\theta = 30^\circ$. The uniform electric field $\vec{\mathbf{E}}$ in the drawing has a magnitude of $3.0 \times 10^2\,\mathrm{N/C}$. Calculate the electric flux across the planar surface.

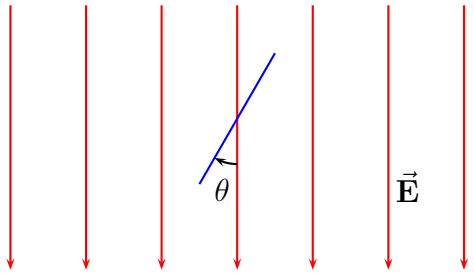

Figure 3: Problem 5.

Caution: Remember that area is a vector normal to the surface.

6. (**10 points.**) The following charges are located inside a spherical shell: $2.80\,\mu$C, $-9.00\,\mu$C, $27.0\,\mu$C, and $-61.2\,\mu$C. Calculate the net electric flux passing through the surface of the shell.

7. (**10 points.**) Two point charges $Q_1 = +4.0\,\text{nC}$ and $Q_2 = -2.0\,\text{nC}$ are separated by a distance $d = 1.0\,\text{m}$. What is the electric potential at a point midway between the charges?

8. (**10 points.**) Four identical charged particles ($q = +1.00\,\mu\text{C}$) are located on the corners of a square of side $L = 10.0\,\text{cm}$. Calculate the change in electric potential energy of the system as the particle at the lower left corner in the figure is brought to this position from infinitely far away. Assume the other three particles remain fixed in position.

9. (**10 points.**) The potential in a region between $x = 0$ and $x = 5.00\,\text{cm}$ is given by

$$V = a + bx, \tag{1}$$

where $a = 0\,\text{V}$ and $b = -450\,\text{V/cm}$. Determine the magnitude and direction of the electric field at $x = 2.00\,\text{cm}$.

10. (**10 points.**) An isolated solid spherical conductor has a radius of 10.0 cm and a charge of 1.0 μC. Calculate the electric field and the electric potential at the center.