Midterm Exam No. 01 (2015 Fall)

PHYS 205B: University Physics

Date: 2015 Sep 17

____________________ (Name)

____________________ (Signature)

Instructions

1. Seating direction: Please be seated on odd-numbered seats.
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.**) Determine the total electric charge (in Coulomb) contained in 1 g of protons.

2. (**10 points.**) Charges $q_1 = +3.0\,\mu\text{C}$ and $q_2 = -9.0\,\mu\text{C}$ are 10.0 cm apart. Presume the two charges to be uniformly spread on identical perfectly conducting spheres of radius 1.0 cm.

   (a) Determine the Coulomb force exerted on charge q_1 by q_2.

   (b) If let go, the two spheres attract, move towards each other, and come in contact. Determine the new charges q_1' and q_2' on the two spheres after they come in contact.

   (c) Is the Coulomb force on the spheres attractive or repulsive after they come in contact?

3. (**10 points.**) Three identical charges of equal magnitude q are placed at the corners of a triangle of length L. Determine the magnitude of the Coulomb force on one of the charges.

4. (**10 points.**) A positively charged plastic ball, $q = +10.0\,\mu\text{C}$ and $m = 1.00\,\text{g}$, is suspended using a $20.0\,\text{cm}$ long string in a uniform electric field $E = 1.0 \times 10^3\,\text{N/C}$ as shown in the figure below. Determine the angle θ the string makes with the vertical when the ball is in equilibrium. (Use $g = 10.0\,\text{m/s}^2$.)

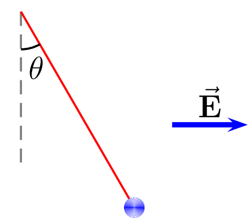

Figure 1: Problem 4.

5. (**10 points.**) Two equal and opposite point 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.

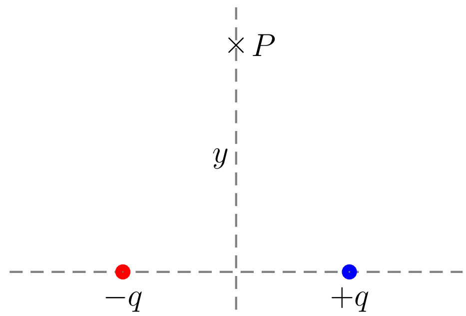

Figure 2: Problem 5.

6. (**10 points.**) See Figure 3. 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?

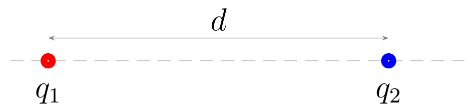

Figure 3: Problem 6.

7. (**10 points.**) An electron is released from rest in a uniform electric field of magnitude $492\,\mathrm{N/C}$. Calculate the speed of the proton $47.2\,\mathrm{ns}$ after being released.

8. (**10 points.**) Consider a region of uniform electric field

$$\vec{\mathbf{E}} = (1.0\,\hat{\mathbf{i}} + 2.0\,\hat{\mathbf{j}}) \times 10^3\,\frac{\mathrm{N}}{\mathrm{C}}. \tag{1}$$

Calculate the electric flux through a rectangular plane 0.40 m wide and 0.20 m long if the plane is parallel to the yz plane.

9. (**10 points.**) A charge of $260\,\mu$C is at the center of a cube of edge 40.0 cm. No other charges are nearby. Find the electric flux through each face of the cube.

10. (**10 points.**) Consider a perfectly conducting sphere of radius $R = 3.0\,\mathrm{cm}$ with charge $Q = 1.0\,\mu\mathrm{C}$. Determine the electric flux through the surface of a (Gaussian) sphere of radius $2.0\,\mathrm{cm}$, concentric with respect to the conducting sphere.