Midterm Exam No. 01 (2015 Spring)

PHYS 205B: University Physics

Date: 2015 Feb 12

(Name) (Signature)

Instructions

1. Total time = 75 minutes.
2. There are 10 questions in this exam.
3. Equation sheet is provided separately.
4. To obtain partial credit for your work you need to show your work in detail and organize it clearly.

1. (**10 points.**) If like charges are placed on Earth and Moon it might be possible to negate the gravitational force between them. (Mass of Earth is $\sim 6 \times 10^{24}\,\mathrm{kg}$, and mass of Moon is $\sim 7 \times 10^{22}\,\mathrm{kg}$. You do not need the knowledge of distance between Earth and Moon for this calculation, which is $R \sim 4 \times 10^{8}\,\mathrm{m}$.)

   (a) Assuming this were feasible, (in practice it is not feasible,) how much charge in Coulombs, on each mass, could achieve this?

   (b) How many kilograms of electrons is required to collect this amount of Coulombs of charge?

2. (**10 points.**) Three point charges are arranged as shown in the Figure 1 below. Find the magnitude and direction of the electric force on the particle $q = 4.00\,\text{nC}$ at the origin. (Let $r_{12} = 0.300\,\text{m}$.)

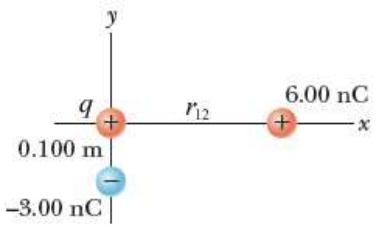

Figure 1: Problem 2.

3. (**10 points.**) Two identical conducting spheres A and B carry equal charge. They are separated by a distance much larger than their diameters. A third identical conducting sphere C is uncharged. Sphere C is first touched to A, then to B, and finally removed.

   (a) As a result, what is the charge on A, if it was originally Q.

   (b) As a result, what is the charge on B, if it was originally Q.

   (c) As a result, what is the electrostatic force between A and B, if it was originally F.

4. (**10 points.**) An object having a mass of 13.0 g and a charge of 6.00×10^{-5} C is placed in an electric field $\vec{\mathbf{E}}$ with components $E_x = 2.30 \times 10^3$ N/C, $E_y = 570$ N/C, and $E_z = 0$.

   (a) What is the force on the object (in vector notation)?

   (b) If the object is released from rest at the origin, what will be its coordinates after 3.00 s?

5. (**10 points.**) See Figure 2. Particle 1 of charge $q_1 = +4.00q$ and particle 2 of charge $q_2 = -1.00q$ are fixed to an x axis. As a multiple of distance L, at what coordinate on the axis is the net electric field of the particles zero?

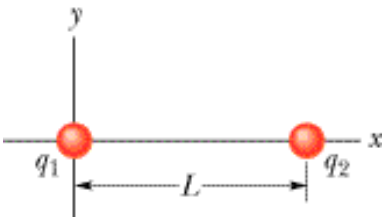

Figure 2: Problem 5.

6. (**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 period of time after being released simultaneously.

   (a) Describe the direction of motion of the electron and proton.

   (b) Determine the ratio

   $$\frac{v_e}{v_p}. \tag{1}$$

   (c) Which of them gains higher momentum?

7. (**10 points.**) In Figure 3, particles 1 and 2 of charge $q_1 = q_2 = +3.00 \times 10^{-19}$ C are placed on a y axis at distance $d = 16.0$ cm from the origin. Particle 3 of charge $q_3 = +6.00 \times 10^{-19}$ C is moved gradually along the x axis from $x = 0$ to $x = +5.0$ m. At what values of x will the magnitude of the electrostatic force on the third particle from the other two particles be maximum?

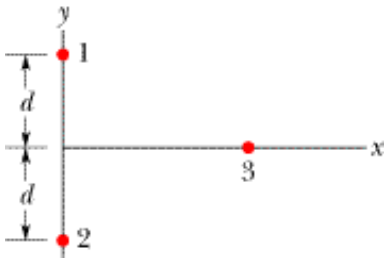

Figure 3: Problem 7.

8. (**10 points.**) When a piece of paper is held with one face perpendicular to a uniform electric field the flux through it is $75\,\mathrm{N{\cdot}m^2/C}$. When the paper is turned 35° with respect to the field what is the flux through it?

9. (**10 points.**) A 8.85 pC point charge is placed at the origin. What is the electric flux through a sphere of radius $R = 5\,\text{cm}$ centered at the origin?

10. (**10 points.**) Positive charge Q is distributed uniformly throughout an insulating sphere of radius R, centered at the origin. A particle with positive charge Q is placed at $x = 2R$ on the x axis. What is the magnitude of the electric field at $x = 3R/2$ on the x axis?