Midterm Exam 02 (2015 Fall)

PHYS 203B: College Physics

Date: 2015 Oct 15

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(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.**) Determine the electric potential at a distance of 2.0 cm from the center of a perfectly conducting sphere of radius 10.0 cm carrying a charge of $1.0\,\mu$C.

2. (**10 points.**) Charges of q and $-2q$ are fixed in place, with a distance of $a = 4.00\,\mathrm{m}$ between them. A dashed line is drawn through the negative charge, perpendicular to the line between the charges. On the dashed line, at a distance y from the negative charge, there is at least one spot where the total potential is zero. Find y.
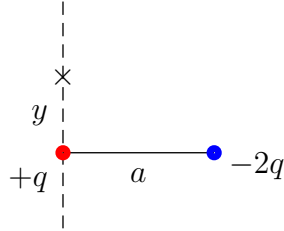
Figure 1: Problem 2

3. (**10 points.**) Determine the electric potential energy for the array of three charges at the corners of an equilateral triangle of side $L = 10.0\,\text{cm}$ in the drawing in Figure 2, relative to its value when the charges are infinitely far away and infinitely far apart. (Let $q = 1.0\,\mu\text{C}$.)
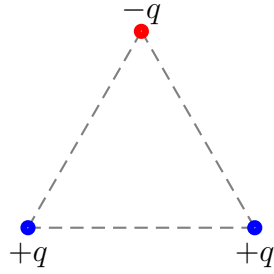

Figure 2: Problem 3

4. (**10 points.**) An electron is released from rest at the negative plate of a parallel plate capacitor and accelerates to the positive plate. The plates are separated by a distance of 3.0 cm, and the electric field within the capacitor has a magnitude of 3.9×10^6 V/m. What is the kinetic energy of the electron just as it reaches the positive plate?

5. (**10 points.**) Two electrons and two protons are placed at the corners of a square of side $5\,\mathrm{cm}$, such that the electrons are at diagonally opposite corners. How much potential energy is required to move another proton from the center of the square to one of the midpoint of either one of the sides of the square?

6. (**10 points.**) Two identical capacitors store different amounts of energy: capacitor A stores 8.0×10^{-3} J, and capacitor B stores 2.0×10^{-3} J. The charge stored in capacitor B is $1.0 \, \mu$C. Find the charge stored in capacitor A.

7. (**10 points.**) A piece of Nichrome wire of resistivity $1.50 \times 10^{-6}\,\Omega$m has a radius of 6.50×10^{-4} m and a total length of 15 m. It is used in a laboratory to make a heater when connected to a voltage source of 120 V. Ignoring the effect of temperature on resistance, estimate the power output of the heater.

8. (**10 points.**) The average cost of electricity in the United States, for residential users, is about $0.15\,\mathrm{USD/kWh}$ (15 cents per kiloWatt-hour). At this rate your electricity bill for a month came out to be $25.00\,\mathrm{USD}$. How much electric energy (in Joules) did you use in the month?

9. (**10 points.**) Figure 3 shows two resistors connected in parallel to a battery. The battery has a voltage of $V = 10.0\,\text{V}$, and the resistors have resistances $R_1 = 100.0\,\Omega$ and $R_2 = 200.0\,\Omega$.
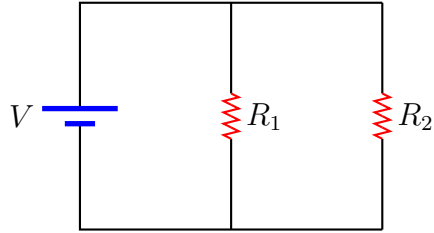

Figure 3: Problem 9

(a) Determine the equivalent resistance across the battery.

(b) Determine the voltage across each of the resistor.

(c) Determine the current passing through each resistor.

(d) Determine the power consumed by each resistor.

10. (**10 points.**) Determine the equivalent capacitance between points A and B in the circuit in Figure 4. Given $C_1 = 1.0\,\mu\mathrm{F}$, $C_2 = 2.0\,\mu\mathrm{F}$, $C_3 = 3.0\,\mu\mathrm{F}$, and $C_4 = 4.0\,\mu\mathrm{F}$.
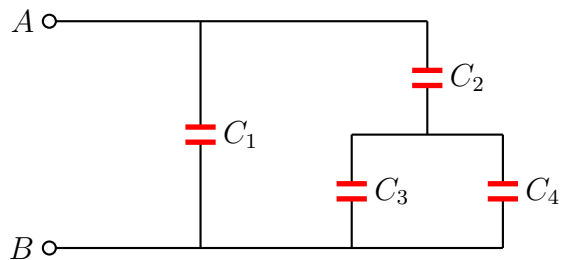

Figure 4: Problem 10