Midterm Exam No. 02 (2015 Fall)

PHYS 205B: University Physics

Date: 2015 Oct 15

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

2. (**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 in the figure below remain fixed in position.

3. (**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 $x = 2.00\,\text{cm}$.

4. (**10 points.**) A 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 of the spherical conductor.

5. (**10 points.**) A sphere with mass $m_2 = 10\,\mathrm{g}$ and charge $q_2 = 1.0\,\mu\mathrm{C}$ is fired directly toward another sphere of charge $q_1 = 10.0\,\mu\mathrm{C}$ (which is pinned down to avoid its motion). If the initial velocity of charge q_2 is $v_i = 10.0\,\mathrm{m/s}$ when it is $r_i = 30\,\mathrm{cm}$ away from charge q_1, at what distance away from the charge q_1 does it come to rest?

6. (**10 points.**) A potential difference $V = 10\,\mathrm{V}$ is applied across a capacitor arrangement with two capacitances connected in series, $C_1 = 10.0\,\mu\mathrm{F}$ and $C_2 = 20.0\,\mu\mathrm{F}$.

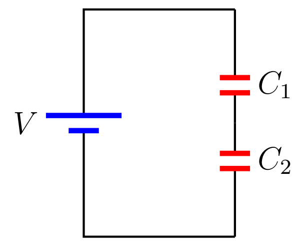

Figure 1: Problem 6

(a) Find the equivalent capacitance.

(b) Find the charges Q_1 and Q_2 on each of the capacitors.

(c) Find the voltages V_1 and V_2 across each of the capacitors.

(d) Find the potential energies U_1 and U_2 stored inside each of the capacitors.

7. (**10 points.**) The resistance R of a wire of length l and uniform area of cross-section A is given by

$$R = \frac{\rho l}{A}, \tag{2}$$

where ρ is the resistivity of the wire. You melt the wire and recast it to have a new length $l' = 10\,l$ (keeping the volume $V = Al$ of the wire constant). What is the new resistance of the wire, if the original resistance of the wire was $100.0\,\Omega$.

8. (**10 points.**) Ten identical $1.00\,\mathrm{k\Omega}$ resistors are connected in parallel to a $10.0\,\mathrm{V}$ battery. Determine the current through one of the resistor.

9. (**10 points.**) Consider the circuit in Figure 2. Given $R_1 = R_2 = R_3 = 100\,\Omega$, $V_1 = 10\,\mathrm{V}$, and $V_2 = 20\,\mathrm{V}$. Determine the currents in each of the resistors.

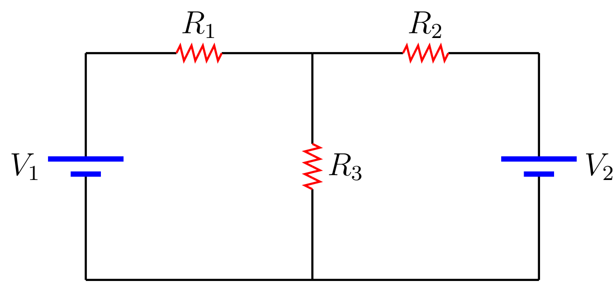

Figure 2: Problem 9

10. (**10 points.**) A capacitor with an initial charge of Q_0 is connected to a resistor. The circuit has a time constant of 1.40 ms. Soon after the switch is closed, after how much time is the charge on the capacitor 50.0% of its initial charge.