Midterm Exam No. 02 (2015 Spring)

PHYS 205B: University Physics

Date: 2015 Mar 19

____________________ (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.**) An electron is accelerated from rest through a potential difference of 10 V. What is the final speed of the electron?

2. (**10 points.**) A particle with a charge of 7.2×10^{-8} C charge is fixed at the origin. A particle with a charge of -2.7×10^{-8} C charge is moved from $x = 3.5$ cm on the x axis to $y = 2.5$ cm on the y axis. What is the change in the potential energy of the two-particle system?

3. (**10 points.**) Two electrons and two protons are placed at the corners of a square of side 5 cm, such that the electrons are at diagonally opposite corners.

   (a) What is the electric potential at the center of square?

   (b) What is the electric potential at the midpoint of either one of the sides of the square?

   (c) How much potential energy is required to move another proton from infinity to the center of the square?

   (d) How much additional potential energy is required to move the proton from the center of the square to one of the midpoint of either one of the sides of the square?

4. (**10 points.**) Consider two spherical conductors connected by a long conducting wire. When charge Q is placed on the combination it distributes such that the potential difference between the spheres is zero. If the second sphere has a radius twice that of the first sphere, find the ratio of the electric field at the surface of the second sphere to that of first sphere.

5. (**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 $C_2 = 20.0\,\mu\mathrm{F}$.

   (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.

6. (**10 points.**) Find the torque acting on an electric dipole moment $\vec{\mathbf{p}} = 3.0 \times 10^{-12}\hat{\mathbf{i}}\,\text{C-m}$ when it is placed in an electric field

$$\vec{\mathbf{E}} = 16\,\hat{\mathbf{j}}\,\frac{\text{N}}{\text{C}}. \tag{1}$$

Report the magnitude and direction of the torque.

7. (**10 points.**) The average cost of electricity in the United States, for residential users, is about 0.10 USD/kWh (10 cents per kiloWatt-hour). At this rate your electricity bill for a month came out to be 50.00 USD. How much electric energy (in Joules) did you use in the month?

8. (**10 points.**) A potential difference $V = 10\,\mathrm{V}$ is applied across a resistor arrangement with two resistances connected in series, $R_1 = 10.0\,\Omega$ and $R_2 = 20.0\,\Omega$.

   (a) Find the equivalent resistance.

   (b) Find the currents I_1 and I_2 through each of the resistors.

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

   (d) Determine the power consumed by each resistor.

9. (**30 points.**) Consider the circuit in Figure 1 with $V_1 = 10\,\mathrm{V}$, $V_2 = 20\,\mathrm{V}$, $R_1 = 10\,\Omega$, $R_2 = 20\,\Omega$, $R_3 = 30\,\Omega$. Find the current i_3 passing through resistor R_3.

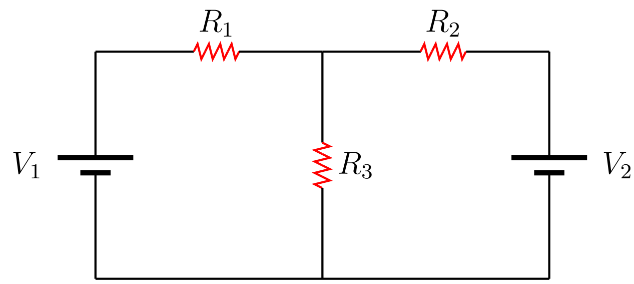

Figure 1: Problem 9

10. (**10 points.**) In terms of the time constant τ, determine the time taken for an initially uncharged capacitor, in an RC series circuit, to be charged to two-third of its final charge.