Physics 211 Final Exam

January 28, 2008

Your name:

ID number:

Time given: 120 minutes

Please provide your reasoning for each step of your solution (providing an answer without a solution is not enough)

Problem 1

A uniformly charged insulating shell has internal and external radii R and $3R$ and the volume charge density is ρ. The points A and B are located at the inner and outer surfaces of the shell, as shown on the Figure 1. Find the potential difference $\Delta V_{AB} = V_B - V_A$.

Problem 2

An electric circuit consists of the 3 batteries with the voltages $\Delta V_1 = 1V$,$\Delta V_2 = 4V$ and $\Delta V_3 = 8V$ and 3 resistors $R_1 = 3\Omega$, $R_2 = 2\Omega$ and $R_3 = 8\Omega$, as shown on the Figure 2. Find the electric currents in each of the resistors.

Problem 3

In the circuit shown on the Figure 3, two capacitors with capacitances $C_1 = C$ and $C_2 = 4C$ are originally disconnected, as shown on the Figure 3, and the capacitor C_1 carries the charge Q while the charge of C_2 is $3Q$. Then the keys A and B are switched on simultaneously. Find the total heat dissipated in the resistor R after the switches A and B are on.

Problem 4

Two point charges $q_1 = 10^{-4}C$ and $q_2 = 10^{-3}C$ are separated by the distance $d = 10^{-2}m$ along the x-axis and move with velocities $vecv_1 = 2\vec{i} + 3\vec{j}(\frac{m}{s})$ and $\vec{v_2} = 3\vec{i} + 4\vec{j}(\frac{m}{s})$ respectively. Find the **magnetic** interaction force between two charges.

Problem 5

A conductor with the cylindrical cross-secrion of the radius R carries the radially symmetric current density $j(r) = \alpha r^2; r \leq R$ where α is a given constant (the current is into the page). Find the magnetic field as the function of the distance from the conductor's symmetry axis, both inside and outside the conductor.

Problem 6

A rectangular contour , consisting of the resistor R and two conducting rods (each of them having the same resistance $2R$) is placed in a uniform magnetic field B (into the page) , perpendicular to the plane of the contour. The rods move with velocities v and $3v$ respectively, as shown on the Figure 6. Find the magnitude and the direction of the current in the resistor R.