Physics 122 Midterm - 14 Feb. 1997

Note: Some constants you may need are $k = 8.99 \times 10^9$ N m^2/C, $\mu_\circ = 4\pi \times 10^{-7}$ H/m, 1 eV $= 1.602 \times 10^{-19}$ J, and for electrons $q/m = 1.7588 \times 10^{11}$ C/kg and $m = 9.11 \times 10^{-31}$ kg.

1. In his famous experiment demonstrating that the atom had a massive nucleus Rutherford (and his students Geiger and Marsden) used a beam of ______________________ which was scattered from a gold foil.

2. We connect in series a 12 V battery, a 100 ohm resistor and a capacitor, $C = 4.0 \times 10^{-5}$ Farads. At the instant we close the switch to complete the circuit the charge on the capacitor is 2.4×10^{-4} Coulombs.

   a) What is the maximum charge on C after a very long time?

   b) Make a rough, qualitative drawing of Q *vs.* t to show how Q varies with time from Q_0 to Q_{max}.

   c) How long does it take, in seconds, for the charge on C to increase from Q_0 to 3.6×10^{-4} Coulombs?

3. In the earth's Van Allen belt we observe electrons whose velocity parallel to the earth's magnetic field ($B = 0.11 \times 10^{-4}$ T in the Van Allen belt) is 5.1×10^6 m/s. The electrons have the same velocity perpendicular to B. Find:

   a) the energy of the electrons in eV.

   b) the radius of the circle (perpendicular to B).

   c) the time the electrons take to complete one circle.

4. A battery (ε=12 V) is connected to 9 equal resistors (R=300 ohms) as shown. How much current flows out of the battery?

5. We have three long parallel wires all lying in a plane separated, as shown, by d=0.5 m. The currents flowing in the wire are: I_1=1.0 A, I_2=2.0 A, I_3=3.0 amps, in the directions indicated. What is the magnitude and direction of the magnetic force, per unit length, on wire 1?