Physics 5C **Midterm 1** April 23, 2008

PRINT YOUR NAME _____

You have an hour and ten minutes to do this exam. You may use one page of formulas.

Section A (25 points): True or False Questions. You will get 3 points for each correct answer and 2 additional points if you also give a correct brief explanation.

i. ____ The electric field is always perpendicular to the equipotential surfaces, and it points in the direction of decreasing electric potential.

ii. ____ If a nonconducting ball has a uniform charge density throughout its volume, the ratio of the electric potential at its center to that at its edge is 1.5.

iii. ____ If a dielectric is inserted between the plates of a disconnected fully-charged parallel plate capacitor, the energy stored in the capacitor is decreased.

iv. ____ If you double the resistance R but keep the voltage V constant, the power dissipated in this resistance decreases by a factor of 4.

v. ____ Ten 100 W bulbs that are on for an hour use a kilowatt-hour of power.

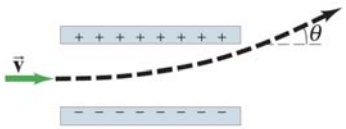
Section B (75 points): Calculation problems. Show all your work and make your method clear in order to get full credit. Use the backs of these pages, and if you need additional paper print your name and the problem number on each sheet.

1. (15 points) Suppose that a charge –Q is located at x = –a, a charge +2Q is located at x = 0, and a charge – Q is located at x = +a.
(a) Calculate the electric potential V(x) on the x-axis for x >> a.
(b) Calculate the electric field on the x-axis for x >> a using Coulomb's law.
(c) Calculate the electric field on the x-axis for x >> a by differentiating the potential.

2. (10 points) A spherical rubber nonconducting balloon carries a total charge Q uniformly distributed on its surface. At time t = 0 the balloon has radius r_0. It is then slowly blown up so that r increases linearly to $2r_0$ in a time T. Determine the electric field as a function of time (a) just outside the balloon, and (b) at r = 3.2 r_0 .

3. (15 points) An electron is accelerated in the *x* (horizontal) direction from rest in a television picture tube by a potential difference of 5500 V. (a) What is the speed v_x of the electron?

(b)The electron then passes between two horizontal plates 6.5 cm long and 1.3 cm apart that have a potential difference in the *y*-direction of ΔV = 250 V, as shown in the figure.



What is the electric field between the plates, neglecting fringing?

(c) At what angle will the electron be traveling after it passes the plates?

4. (10 points) In nuclear fission, a large nucleus splits into two unequal smaller nuclei plus a few neutrons. Suppose one of the smaller nuclei has charge $q_1 = +38e$ and radius $r_1 = 5.5$ fm and the other has $q_2 = +54e$ and $r_2 = 6.2$ fm. As the fission fragments fly apart their electric potential energy is all converted to kinetic energy. What is the resulting kinetic energy of these fragments in MeV? (Note: fm = 10^{-15} m, 1 MeV = 10^6 eV.)

5. (10 points) There is an electric field near the earth's surface of about 150 V/m. How much energy is stored per cubic meter in this electric field?

6. (15 points) The average person in the U.S. consumes 1.40 kW of electricity (averaged over time), but Californians use less energy per capita than residents of any other state, only about 0.80 kW.
(a) At the PG&E current average cost of residential electricity of $0.17 per kWh, how much does an average Californian's electricity cost per person per year?
(b) On average, each kWh of electricity generation in the U.S. produces 1.35 lb of carbon dioxide, but California uses less fossil fuel to generate electricity and as a result each kWh of electricity generated by PG&E produces about 0.52 lb of carbon dioxide. How much CO_2 per year is produced by the average American's electricity use?
(c) How much CO_2 per year is produced by the average PG&E customer's electricity use?