

Physics 230 B01 / EB01 Midterm Exam

Date: Monday, March 20, 2006
Instructor: Dr. Mark Freeman

Time: 11:00 a.m. – 11:50 a.m.
Place: TL 1 2

Instructions:

Attempt all three problems. The total is 60 points.

Keep in mind that even if you cannot solve an entire problem, you may be able to do parts of it. Show your work, but neatly cross out anything you do not want to have graded. Use the flip side of the question page if you run out of space.

You are allowed a calculator and a two-sided formula sheet. Please hand in your formula sheet with your exam. It will be returned with the exam (please ensure that your name is on your formula sheet as well as on your test paper.)

Name: _____

Student ID#: _____

Signature: _____

Useful constants:

..... C

1. (20 Points)

An isolated parallel-plate capacitor (not connected to a battery) has a charge of $Q = 1.4 \times 10^{-5} \text{ C}$. The separation between the plates initially is $d = 1.2 \text{ mm}$, and for this separation the capacitance is $3.1 \times 10^{-11} \text{ F}$. Calculate the work that must be done to pull the plates apart until their separation becomes 4.5 mm , if the charge on the plates remains constant. The capacitor plates are in a vacuum.

2. **(20 Points)**

A parallel plate capacitor is made using two square plates, 6.38 cm on a side, spaced 0.380 cm apart. An electron is sent through the plates with speed $1.74 \times 10^6 \text{ m/s}$ and is deflected 30.0° . Find the charge on each plate.

3. An air capacitor is formed from two conducting spherical shells which are concentric, and have radii of $r_i = 12$ mm and $r_o = 89$ mm. The electric potential of the inner conductor with respect to the outer conductor is +900 V.
[Note: this question has three parts, (a), (b), and (c).]

(a) **(5 points)** Where is the energy density a maximum within the capacitor?

(b) **(10 points)** What is the charge density (charge per unit area) on the surface of the inner conductor?

3(c) (5 points) What is the maximum energy density within the capacitor, in J/m^3 ?