

MIDTERM 2

Physics 9C-03

NAME:

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Social Sec. #:

General Instructions: This examination is closed book. Only a calculator is allowed. Please show all your work and box your answers. Credit will only be given for *complete* solutions. Answers must have correct units. There are seven problems on four pages. Note that not all the problems are worth the same number of points. The constant $k = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$.

- [10 points] 1. Consider two parallel metallic plates of area A and separation d , one with charge $+Q$ and the other with charge $-Q$.
- What is the electric field between the plates?
 - What is the potential difference between the plates?
 - Use the definition of capacitance and the results of (a,b) to derive a formula for C .

- [10 points] 2. A 12 Volt car battery can deliver a total charge of 200 Ampere-hours.
- What is the total stored energy?
 - How long can this battery supply 200 Watts to a pair of headlights?

- [10 points] 3. A $2\ \mu F$ capacitor is charged to 50 Volts. After charging, the capacitor is disconnected from the voltage source, and is connected to another uncharged capacitor. The final voltage is 20 Volts.
- What is the capacitance of the other capacitor?
 - How much energy is lost when the connection is made?

- [20 points] 4. A spherical capacitor consists of two thin concentric spherical shells of radii R_1 and R_2 . Show that the capacitance is given by $C = 4\pi\epsilon_0 R_1 R_2 / (R_2 - R_1)$.

[10 points] 5. Circle the appropriate response.

a. About how fast are the *random* thermal velocities of electrons in a typical wire?

10^{-5} meters/sec. 10^5 meters/sec. 10^8 meters/sec.

b. About how fast do electrons drift in a typical wire and typical voltage?

10^{-5} meters/sec. 10^5 meters/sec. 10^8 meters/sec.

c. About how fast do electric signals propagate in a wire?

10^{-5} meters/sec. 10^5 meters/sec. 10^8 meters/sec.

[20 points] 6. Find the current in the battery in the circuit shown. Find the potentials at the points **b**, **c**, and **d** given that the potential at **a** is $V_{\mathbf{a}} = 0$.

[20 points] 7. The capacitors in the figure are initially uncharged.

- a. What is the initial value of the battery current when the switch S is closed? [**Hint:** If the capacitors are uncharged initially, then the potential across them is zero initially.]
- b. What is the battery current after a long time?
- c. What are the charges on the capacitors after a long time?