Physics 152 Roster No.:_______________________

Score:_________24 pts. possible_______

FALL 2005 Midterm Exam #1, Part A

Exam time limit: 50 minutes. You may use a calculator and both sides of ONE sheet of notes, *handwritten only*. Closed book; no collaboration.

For multiple choice questions, circle the letter of the one best answer (unless more than one answer is asked for). **Show your work** on all free-response questions. Be sure to use **proper units** and **significant figures** in your final answers.

Ignore gravity and relativistic effects in all problems, unless told otherwise.

$k_e = 8.988 \times 10^9$ N·m^2/C^2 $\quad e = 1.602 \times 10^{-19}$ C $\quad m_e = 9.109 \times 10^{-31}$ kg
$\varepsilon_0 = 1/4\pi k_e = 8.854 \times 10^{-12}$ C^2/(N·m^2) $\quad m_p = 1.673 \times 10^{-27}$ kg

1. (8 pts.) **Convert** the following quantities into the given units. Fill in the blanks. (You do NOT need to show your work.) Use *scientific notation* where appropriate (very large or very small values), and express all final values to *2 significant figures*.

a. 2400 keV = _______________________ MeV

b. 85 GW = _________________________ mW

c. 2.0 m^2 = __________________________ mm^2

d. 3.0×10^6 V/m = ___________________ kV/cm

2. (3 pts. total) **TRUE or FALSE (T or F):**

______ Conductors contain both protons and electrons, while insulators contain only neutrons.

______ An electron has a charge of $-e$, while a proton's charge depends on which element it belongs to.

______ Insulators have very large resistivity, while superconductors have a resistivity of zero.

______ 1 volt = 1 joule/coulomb

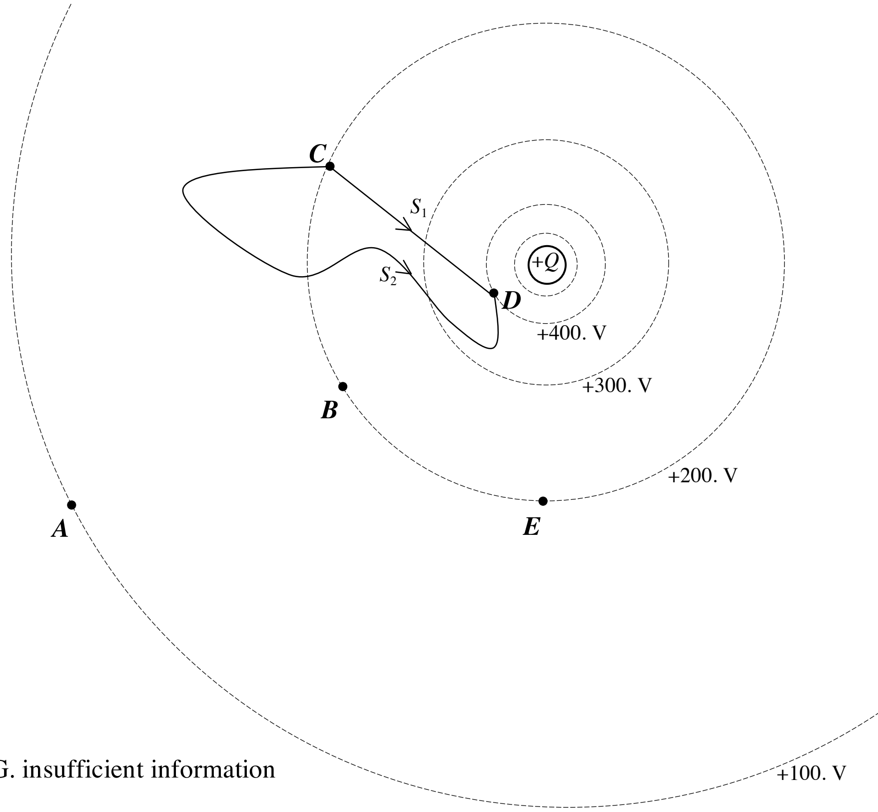
______ 1 watt = 1 joule · second

______ 1 ohm = 1 amp/volt

3. (2 pts.) What is the **peak voltage** of a 60.0-Hz AC voltage that has 138 kV rms?

A. 78.0 kV D. 195 kV
B. 97.6 kV E. 230. kV
C. 170. kV F. 276 kV

4. Shown at right is a large positive point charge $+Q$, surrounded by lines (surfaces) of constant potential. Assume that $V = 0$ at $r = \infty$.



a. How much **work** must be done on a *proton* to move it…

(i). (2 pts.) …from point C to point D, along the *direct path* S_1?

A. zero D. 200. eV
B. 100. eV E. 320. eV
C. 173 eV F. 400 eV
G. insufficient information

(ii). (1 pt.) …from point C to point D, along the *roundabout path* S_2?

A. zero D. 200. eV
B. 100. eV E. 320. eV
C. 173 eV F. 400 eV
G. insufficient information

(iii). (1 pt.) …from point B to point C?

A. zero D. 200. eV
B. 100. eV E. 320. eV G. insufficient information
C. 173 eV F. 400 eV

(iv). (1 pt.) …from extremely far away ($r = \infty$) to point E?

A. zero D. 200. eV
B. 100. eV E. 320. eV G. insufficient information
C. 173 eV F. 400 eV

b. (1 pt.) $+Q$ creates an **electric field** at point B that points in which **direction**?

A. toward point A D. toward point D
B. no field E. toward point E
C. toward point C F. out of the page

c. (1 pt.) If you released an *electron* at point B, in which **direction** would it feel a **force**?

A. toward point A D. toward point D
B. no force E. toward point E
C. toward point C F. out of the page

d. (4 pts.) If the +300.-volt equipotential surface is located 10.0 cm away from the point charge $+Q$, calculate the **charge** Q:

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Score: <u>26 pts. possible</u>

FALL 2005 Midterm Exam #1, Part B

1. Suppose you have two 50.0-Ω resistors and one 100.0-Ω resistor.

a. If you connect *all 3 resistors in parallel* to a 12.0-V DC battery…

(**i**). (3 pts.) What is the **equivalent resistance** R_{eq} of the 3 resistors?

(**ii**). (3 pts.) What is the **current** through the battery?

(**iii**). (2 pts.) Which ONE OR MORE of the following quantities is/are the **same** for all 3 resistors when they are all connected to the same battery in *parallel,* as above? ***Circle all that apply:***

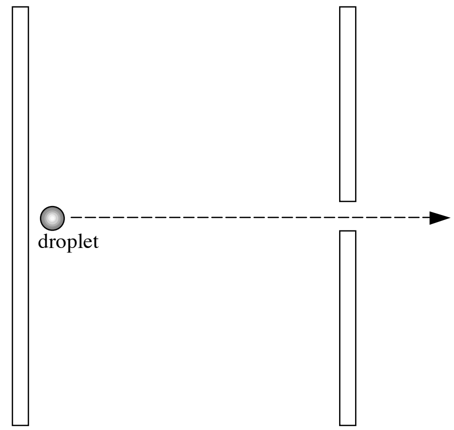
A. current
B. voltage drop
C. power dissipated
D. resistance

(iv). (2 pts.) What is the **total power** dissipated by *all three resistors* in the above arrangement?

A. 7.20 W
B. 12.0 W
C. 17.5 W
D. 20.0 W
E. 27.2 W
F. 35.8 W

b. (4 pts.) Devise a **new arrangement** of the same 3 resistors that has a total equivalent resistance of R_{eq} = 83.3 Ω. **Draw a schematic diagram** of it (including the battery) below. **Show** that R_{eq} = 83.3 Ω with a calculation.

2. Inside an inkjet printer, a small *negatively*-charged droplet of ink is accelerated between two charged parallel plates. The droplet starts *at rest* near the left-hand plate, and it reaches a final speed of v_f just as it passes through a small hole in the right-hand plate. (Ignore gravity throughout this problem.)



a. (1 pt.) **Label** the plates + and –.

b. (2 pts.) **Sketch** the **E field lines** between the plates, including directional **arrowheads**. (Assume the plates are ideal and infinite. Ignore "fringes.")

c. (2 pts.) Suppose that the potential difference between the two plates is 150 kV. **Sketch and label** the 50-kV and 100-kV **equipotential lines**, assuming the negative plate is at 0 V. (Assume the plates are ideal and infinite. Ignore "fringes.")

d. (1 pt.) Which one of the following best describes the magnitude of the **electric force** acting on the droplet as it crosses the gap between the plates from left to right?

A. progressively stronger
B. constant
C. progressively weaker

e. (2 pts.) Which ONE OR MORE of the following would *increase* the magnitude of the **electric force** acting on the droplet? (Consider each possible modification *separately and independently* from the others.)

A. increasing the potential difference between the plates
B. increasing the plate separation
C. increasing the charge on each plate
D. increasing the charge on the droplet

f. (4 pts.) If the droplet starts from rest, find an expression for its **final speed v_f** in terms of the following variables:

m = mass of the droplet d = plate separation
q = net charge on the droplet V = potential difference between the plates

…and any necessary physical constants. (Ignore gravity and air resistance.) Your final expression may or may not require all four of the above variables, but do NOT include any other variables — rewrite them in terms of the variables given.

Possibly useful formulas: $KE = m\,v^2/2$ $F = m\,a$ $v^2 = v_0^2 + 2\,a\,\Delta x$