NAME:_____

DATE:_____

PHY 1308:
General Physics II
Electricity and Magnetism

Exam 2

RULES AND NOTES

- You have 50 minutes to complete this exam.
- Write your name and the date on the cover sheet, and hand in this exam at the end. Please attach any extra work on additional paper.
- Attach your formula sheet to your exam as well as any scratch paper on which you perform your calculations.
- Show all work. Writing down an answer, even the correct answer, without showing work will result in significant loss of points.

Potentially Useful Formulas

$$u_E = \frac{1}{2} E^2 \epsilon_0$$

$$U = \frac{1}{2} C V^2$$

$$\Delta V_{AB} = -\int \vec{E} \cdot d\vec{r}$$

$$\Delta V_{AB} = -W_{AB}/q$$

$$\rho = R A / L$$

$$Q = (\epsilon_0 A / d) V$$

$$\epsilon_0 = 8.85 \times 10^{-12} C^2/(N \cdot m^2)$$

$$k = 9.0 \times 10^9 (N \cdot m^2)/C^2$$

MULTIPLE CHOICE (20 Points)

Select only ONE answer for each of the following multiple choice questions. Each question is worth 5 points.

QUESTION 1: A uncharged capacitor (capacitance C) is attached in series to a resistor (resistance R), a battery (voltage V), and an initially open switch. Just after the switch is closed, which one of the following statements is true?

(a) The capacitor acts like an infinite resistor, preventing current from flowing.
(b) The resistor and capacitor provide a time constant, RC, given by RC = R + C.
(c) The capacitor acts like an open circuit, allowing current flow determined by I=V/R.
(d) The resistor has a reduced resistance given by R/C.

YOUR ANSWER:_____

QUESTION 2: Which of the following is true about resistance?

(a) Resistance increases as the length of the resistor increases.
(b) Resistance decreases as the area of the resistor decreases.
(c) Resistance increases as the resistivity decreases.
(d) Resistance increases as the conductivity increases.

YOUR ANSWER:_____

QUESTION 3: The positive direction of current flow is defined as . . .

(a) The direction in which negative charge is moving.
(b) The direction in which positive charge is moving.
(c) The direction I draw my arrows when applying Kirchoff's Loop Law.
(d) The direction from the positive to the negative terminal of any individual battery.

YOUR ANSWER:_____

QUESTION 4: You have two lamps. You plug them into a power strip (see picture above), which is then plugged into the wall. Both lights shine as brightly when plugged into the strip as when each is individually plugged into the wall. This means that . . .

(a) The power strip must be wired so that the lamps are in parallel.
(b) The power strip must be wired so that the lamps are in series.

YOUR ANSWER:_____

PROBLEM 1 (50 Points)

You are trapped outside on open ground during a lightning storm.

- (a.) Treat the ground and the bottom of the cloud layer as flat parallel plates in a large capacitor. What is the capacitance of each square kilometer of this system?

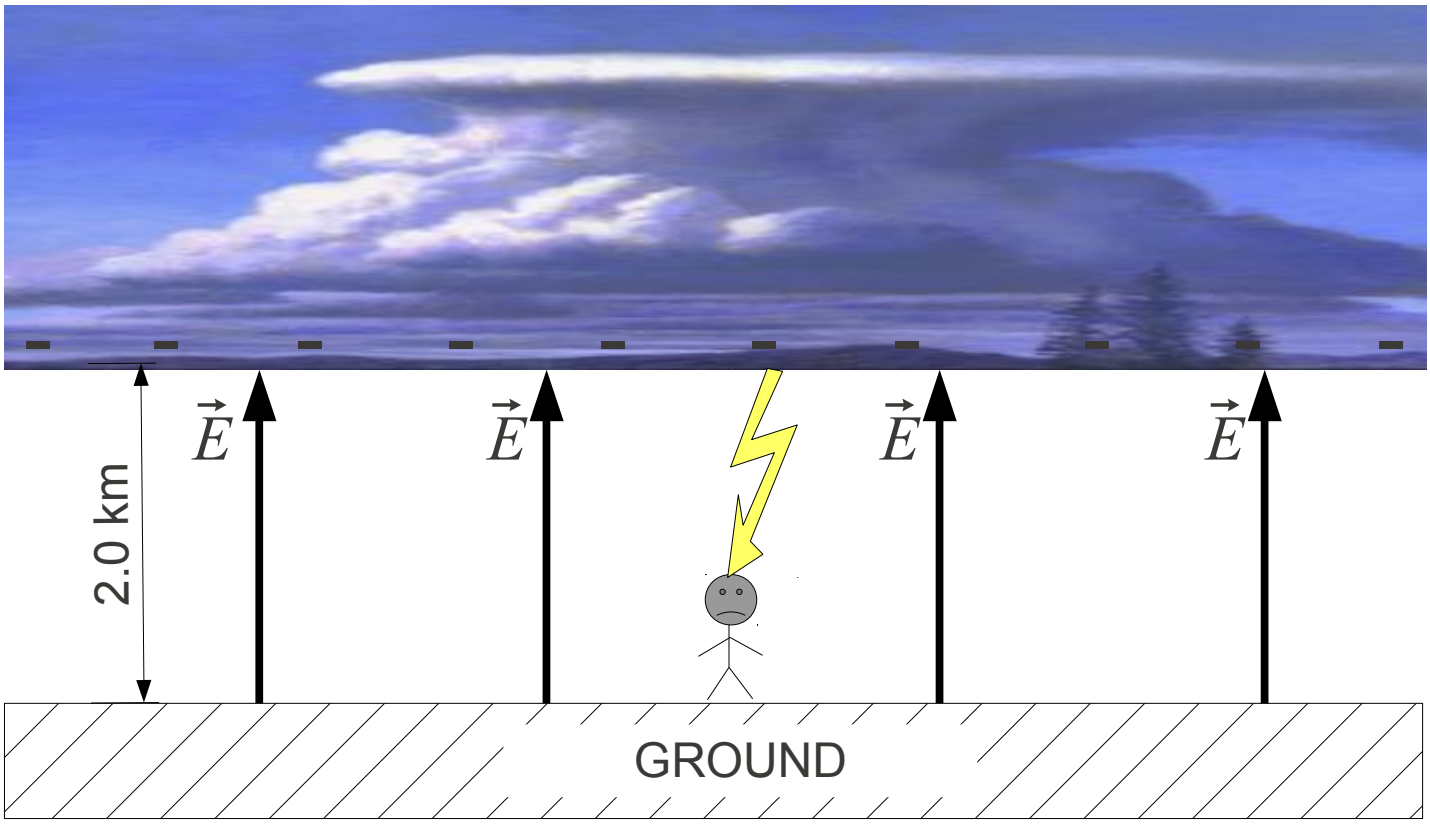
- (b.) This capacitor is capable of holding a uniform electric field whose maximum magnitude (before air's resistance breaks down and it becomes a perfect conductor) is 5.0×10^4 N/C. How much charge is stored in each square-kilometer of the system? *(HINT: you need to calculate the potential difference, V, in the system)*

You are stuck by lightning. This occurs when the air between your head and the bottom of the clouds breaks down under the stress of the electric field; the air becomes a perfect conductor. You are then like a resistor, whose feet are attached to the positive terminal of a battery; a perfect conductor stretches from your head to the base of the clouds. The base of the clouds is like the negative terminal of the battery.

- (c.) Assume that the path the lightning bolt takes through your body, from head to toe, is 1.6m long. A typical lightning bolt is about 3.0cm in diameter. The average resistivity of the human body is 5.0 Ωm. Treating the path of the lightning like a cylinder, what is the total resistance to the current flow?

- (d) How much current is driven through your body?

- (e) How much power is dissipated through your body by the lightning strike?



PROBLEM 2 (30 Points)

Calculate the RC constant (the product of resistance and capacitance) for the circuit depicted below. All resistors have resistance R=100.0Ω and all capacitors have capacitance 1.0F.