NAME:_____

DATE:_____

PHY 1308:
General Physics II
Electricity and Magnetism

Exam 3

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

$$u_B = \frac{1}{2\mu_0} B^2$$

$$V = IR$$

$$Q = VC$$

$$\varepsilon_L = -L\frac{dI}{dt}$$

$$\vec{\tau} = \vec{\mu} \times \vec{B}$$

$$\mu = NIA$$

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

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

$$\mu_0 = 4\pi \times 10^{-7}\, \mathrm{N/A^2}$$
$$= 1.26 \times 10^6\, \mathrm{N/A^2}$$

MULTIPLE CHOICE (20 Points)

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

QUESTION 1: Self-inductance refers to what property of a conductor?

(a) The tendency to resist changes to enclosed magnetic flux.
(b) The tendency to reinforce changes to enclosed magnetic flux.
(c) The tendency of an external permanent magnet to cause electric current to flow.
(d) The tendency of an external solenoid to cause electric current to flow.

YOUR ANSWER:_____

QUESTION 2: Magnetic fields are caused by . . .

(a) Static (unmoving) electric charge.
(b) Moving electric charge.
(c) The force between electric charges in an electric dipole.
(d) Individual magnetic charges, just like electric fields are caused by electric charges.

YOUR ANSWER:_____

QUESTION 3: The magnetic force on a charged particle is GREATEST when . . .

(a) the particle is moving parallel to a magnetic field.
(b) the particle is moving anti-parallel to (against) a magnetic field.
(c) the particle is moving at a right-angle (90-degrees) to a magnetic field.
(d) the particle is moving at a 45-degree-angle to a magnetic field.

YOUR ANSWER:_____

QUESTION 4: Two wires lay parallel to each other. The magnetic force between them is *attractive* when . . .

(a) There is current in one wire but not in the other.
(b) There are currents in both wires that flow in the same direction.
(c) There are currents in both wires that flow in the opposite directions.
(d) There is no current at all in either wire.

YOUR ANSWER:_____

PROBLEM 1 (40 Points)

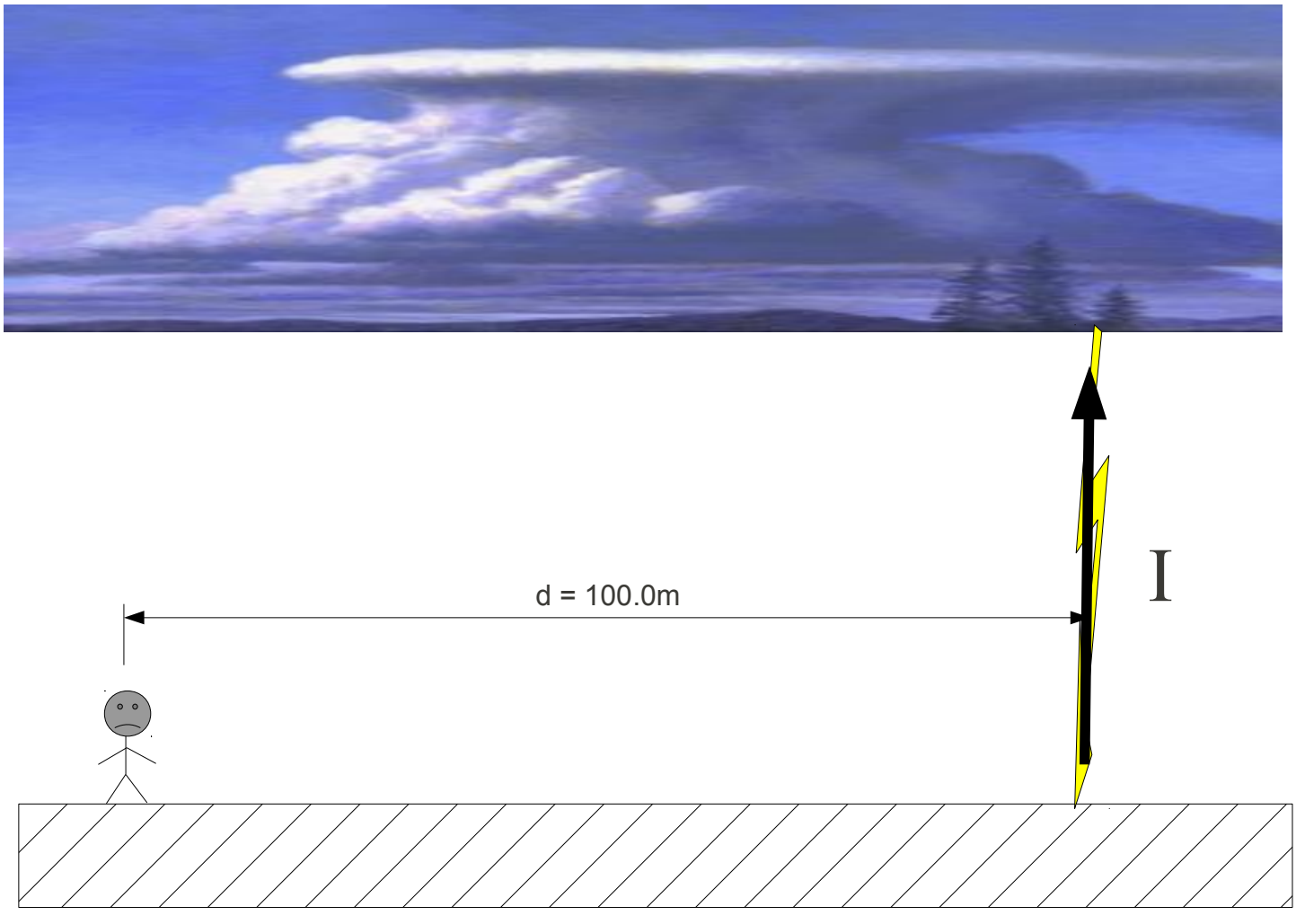
Lightning strikes near you during a lightning storm. The lightning is far enough away that its thickness is negligible, and the lightning bolt is a perfectly straight line from the clouds to the ground (see illustration below). Thus the magnetic field from the lightning strike is given by

$$B = \frac{\mu_0 I}{2\pi d}$$

- **(a.) (10 Points)** You are standing to the left of the lightning bolt, as illustrated below, a distance d=100.0m away. **What direction is the magnetic field pointing at your location?** Indicate with an arrow, or if the field points out of the page use a thick dot, or if the magnetic field points into the page use an "X".

- **(b.) (20 Points)** You are wearing a circular hoop earring whose radius is 5.0mm and whose area vector, $\vec{A}$, makes a 30-degree angle with respect to the magnetic field at your present distance from the wire. If the current in the lightning strike rises steadily from zero and reaches its maximum of I = 250 × 10^3 A after 0.15s, what is the electromotive force induced in the earring by the magnetic field from the lightning? Treat the magnetic field as uniform at your distance from the lightning strike.

- **(c.) (10 Points)** The earring is made from a material with a resistance of 6.0 × 10^{-10}Ω. What current is established in the earring by the induced electromotive force?



PROBLEM 2 (40 Points)

Consider the circuit shown below. The circuit components are small and make negligible contributions to the overall rectangular shape of the circuit.

- **(1.) [10 Points]** What is the current in the circuit a long time after the battery has been connected to the circuit?

- **(2.) [10 Points]** The magnetic dipole moment of this circuit points into the paper. What is the *magnitude* of the magnetic dipole moment of the circuit?

- **(3.) [10 Points]** A uniform external magnetic field of strength B_{ext} = 0.50T is applied to the ***top half*** of the circuit. This external field points into the paper. What is the net force on the circuit?

- **(4.) [10 Points]** Will the circuit ROTATE as a result of this applied force? Explain your answer.