Physics 152 Roster No.:__________________________

Score: ___________**19 pts. possible**________

FALL 2003 Midterm Exam #2, 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). Ignore gravity and relativistic effects in all problems, unless told otherwise.

$k_e = 8.988 \times 10^9$ N·m²/C² $e = 1.602 \times 10^{-19}$ C $m_e = 9.109 \times 10^{-31}$ kg

$\varepsilon_0 = 1/(4\pi k_e) = 8.854 \times 10^{-12}$ C²/(N·m²) $c = 2.998 \times 10^8$ m/s $m_p = 1.673 \times 10^{-27}$ kg

$\mu_0 = 4\pi \times 10^{-7}$ T·m/A

(1 point each, unless otherwise specified)

1. (2 pts.) Which THREE of the following could you place next to a very strong magnet **without** any permanent harm? *Circle three:*

A. compact disc C. floppy disk E. videotape
B. credit card D. car keys F. your little sister

2. (2 pts.) Which THREE of the following primarily depend on the use of **magnetic fields** (either permanent or created with currents) in order to function? *Circle three:*

A. DC motors C. telescopes E. particle accelerators
B. loudspeakers D. electric ovens F. gyroscopes

3. All of the following statements are true **EXCEPT**:

A. The Earth's North geographical pole is near its South magnetic pole.
B. The Earth's magnetic field gets weaker the farther you get from the Earth's surface.
C. The Earth's magnetic field is created by the orbital motion of charged particles high above the atmosphere.
D. The Earth's magnetic field is able to trap high-speed charged particles, preventing them from reaching the surface of the Earth, and thereby protecting life on Earth.
E. The Earth's magnetic field is responsible for creating the auroras.
F. The Earth's magnetic field is running through you right now. (This one is true!)

4. An approximate value for the **strength of the Earth's *B* field** at the Earth's surface is:

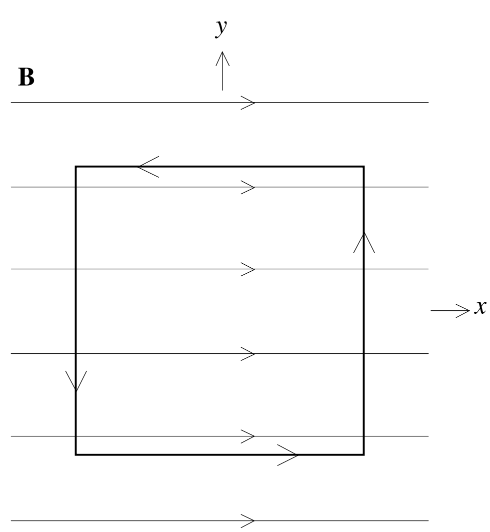
A. 1 gauss D. 1 tesla
B. 10^{-2} gauss E. 10^2 tesla
C. 10^{-4} gauss F. 10^4 tesla

5. All of the following statements are true **EXCEPT**:

A. Magnetic N poles always exert a repulsive force on other magnetic N poles.
B. Magnetism ultimately arises at the atomic level, where individual atoms have N and S poles.
C. In ferromagnetism, the atoms inside one "domain" have their magnetic poles aligned together.
D. Lone magnetic N poles or S poles have been observed in laboratory experiments, but are not usually encountered in everyday life.

6. a. A square wire loop in the plane of the page carries a current *counter-clockwise*. It lies in a uniform **B**-field pointing *to the right*, as shown. Once released, the loop will begin to **spin**...

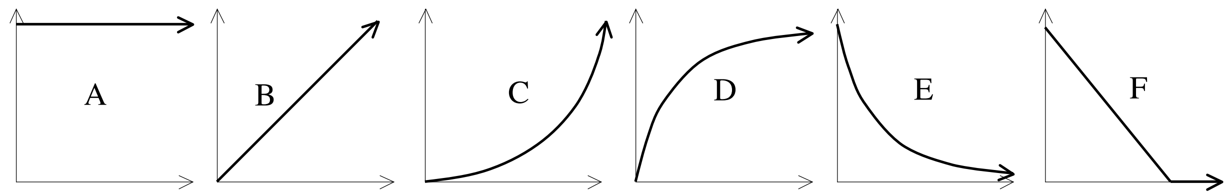
A. about the x-axis
B. about the y-axis
C. clockwise
D. counterclockwise



b. If we wanted to keep the loop spinning in the **same direction** forever, we would **need** to...

A. alternate the direction of current
B. alternate the direction of **B** field
C. either A or B
D. do nothing

7. a. You connect an inductor L and a resistor R in series to a *DC battery* at time $t = 0$. The **current** in the circuit as a function of time looks like which one of the following graphs?



b. After a long period of time (many time constants), the current in the circuit will reach a steady value. What could you do to the circuit to **shorten that time period**?

A. increase V of battery
B. increase L
C. increase R
D. A and B
E. B and C
F. A, B, and C

8. (2 pts.) Suppose you want to build a series LRC circuit that has a resonant frequency of 60. Hz. What **capacitance** could you connect in series with an 850-mH inductor and a 3.5-Ω resistor to accomplish that?

A. 6.8×10^{-11} F
B. 8.3×10^{-6} F
C. 2.7×10^{-3} F
D. 1.2 F
E. 380 F
F. 1.2×10^{5} F

9. (2 pts.) Your "AC adaptor" that runs your portable CD player takes 170-volt household voltage and turns it into 4.5-volt output. (Ignore the fact that it also "rectifies" the AC into DC.) What is the **ratio** of primary to secondary **windings** of the transformer, and which way is the transformer used? ***Choose one from each column:***

A. 38
B. 770
C. 1400

A. step-up
B. step-down

10. All of the following are true about an **electromagnetic wave EXCEPT**:

A. It always has a wavelength, a frequency, and a speed.
B. It consists of perpendicular **E** and **B** fields, but neither points along its direction of propagation.
C. Its **E** field and **B** field are constant in magnitude and direction.
D. It carries energy, partly in the **E** field and partly in the **B** field.
E. You are being hit by EM waves right now.

11. (3 pts.) **TRUE or FALSE (T or F)** for EM waves in **empty space** (vacuum):

______ Red light travels faster than violet light.

______ Radio waves travel slower than x-rays.

______ Red light has slightly longer wavelength than infrared light.

______ Microwaves have longer wavelengths than visible light.

______ Green light has higher frequency than blue light.

______ X-rays have higher frequency than radio waves.

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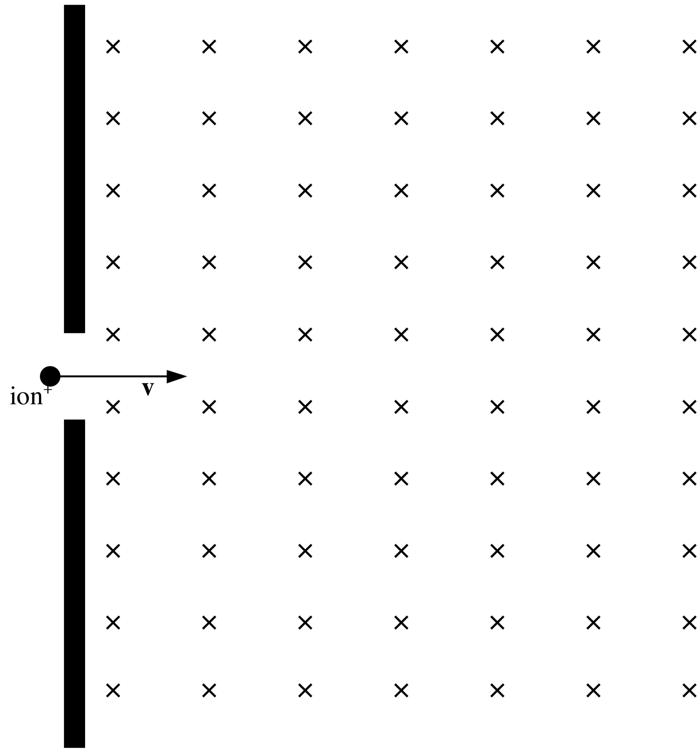
Score: ___31 pts. possible___

FALL 2003 Midterm Exam #2, Part B

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.

1. Inside the main part of a mass spectrometer, *positively* charged ions enter a region containing a uniform **B**-field into the page, as shown at right.



a. (1 pt.) Immediately after a positively charged ion enters the **B**-field from the left with velocity **v**, as shown, in which **direction** will there be a **magnetic force** on it?

A. into the page D. to the left
B. out of the page E. toward top of page
C. to the right F. toward bottom of page

b. (2 pts.) **Sketch the ion's path** inside the **B**-field, starting at the point where the ion first enters the **B**-field. Include directional **arrowheads** on the path.

c. (6 pts.) Suppose you measure the path of a particular positive ion to have a radius of 16.8 cm. You know that the ion enters the **B**-field with a speed of 3.00×10^5 m/s, the magnetic field strength is 1.50 T, and ion has a net charge of +1 (i.e., it is missing just one electron). Deduce **which one of the ion species listed below** the ion must be. Show your work.
(atomic mass unit: 1 u = 1.6605×10^{-27} kg)

Species	Mass [u]
$^{78}Se^+$	77.9168
$^{79}Br^+$	78.9178
$^{80}Se^+$	79.9160
$^{81}Br^+$	80.9158
$^{82}Se^+$	81.9162
$^{84}Kr^+$	83.9110

d. (1 pt.) You could have made the ion's path through the above region a straight line if, before the ion entered, you had superimposed an **E**-field in the same region of space as the **B**-field. In what **direction** should the **E**-field have pointed in order to do this?

A. into the page C. to the right E. toward top of page
B. out of the page D. to the left F. toward bottom of page

2. Suppose that you are in your home or dorm room in Honolulu.

a. (1 pt.) In which geographical **direction** (approximately) does the **Earth's magnetic field** point through your room?

A. north
B. south
C. east
D. west
E. up (toward the ceiling)
F. down (toward the floor)

b. (1 pt.) You lay a straight wire on a flat table in your room, and you can orient the wire in whatever direction you wish. As you put a strong DC current through the wire, a **magnetic force** arises on the wire due to the Earth's **B**-field. If you want the force on the wire to be directed toward the ceiling, *and* you want the force to be as large as possible, in which **direction** must you point the **current**?

A. north
B. south
C. east
D. west
E. up (toward the ceiling)
F. down (toward the floor)

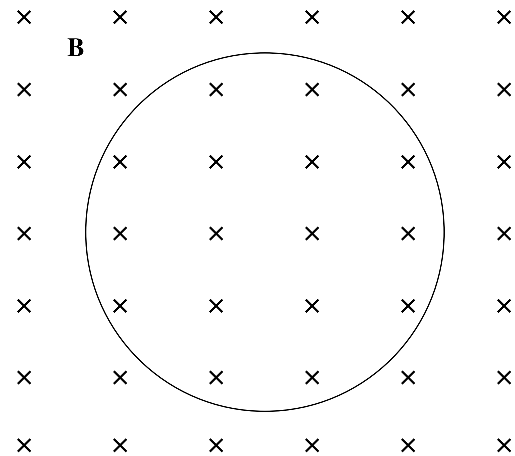
c. (4 pts.) Suppose that the weight of the wire is 0.30 N, and it is 0.85 m long. If the strength of the Earth's **B**-field at your location is 7.5×10^{-5} T, what is the minimum DC **current** you must run through the wire to make it levitate off the table (i.e., to cancel its weight)?

d. (2 pts.) Your answer to part (c) should have been an impractically large amount of current (thousands of amps). Which ONE OR MORE of the following would **reduce the minimum current** needed to levitate the wire? *Circle all that apply:*

A. Lifting the wire farther from the center of the Earth, where the **B**-field is weaker.
B. Orienting the wire as closely as possible along the same direction as the Earth's **B**-field.
C. Using alternating current instead of DC.
D. Using a longer piece of wire which still has a total weight of 0.30 N.

3. Exactly 100 turns of wire are coiled into a 2.50-cm-radius circular loop, lying in the plane of the page. The loop is placed in a uniform **B** field directed *into the page*, as shown. The total resistance of the wire is 3.00 ohms.

a. (7 pts.) If the strength of the **B** field increases from zero to 2.00 T during exactly 1/60th of a second, what is the magnitude of the **CURRENT** (not just the emf) induced in the wire? Show your work.



b. (1 pt.) Draw **arrowheads** on the wire loop in the diagram to show the **direction** (clockwise or counter-CW) of the induced current.

c. (5 pts.) Qualitatively, **how** would your answers to parts (a) and (b) have **changed** if any *one* of the following individual changes had been made to the initial situation described above? (Consider only one change at a time to the initial situation; they are *not* cumulative.)

	part (a): **STRENGTH of current**	part (b): **DIRECTION of current**
Example: **B** had decreased from 2.00 T to zero	unchanged	opposite
Example: loop had only 75 windings	weaker	unchanged
time for Δ**B** had been 1/30th of a second	______	______
direction of **B** had been out of page (instead of into page)	______	______
direction of **B** had been to left	______	______
B held constant at 2.00 T into page, while *radius* of loop had doubled during 1/60th sec.	______	______