

Name: _____ ID: _____ Lab (day/time): _____

Physics 203

Final Exam

6/10/2019

Collaboration is not allowed. Allowed on your desk are: up to ten 8.5 x 11 inch doubled sided sheets of notes that are bound together, non-communicating scientific calculator, 10 pages of scratch paper, writing utensils, a ruler, and the exam. You will have 110 minutes to complete this exam.

Constants:

$$v_{\text{sound}} = 343 \frac{\text{m}}{\text{s}}, \quad c = 3 \times 10^8 \frac{\text{m}}{\text{s}}, \quad k = 8.99 \times 10^9 \text{ N} \frac{\text{m}^2}{\text{C}^2}, \quad \mu_0 = 4\pi \times 10^{-7} \frac{\text{Tm}}{\text{A}},$$

$$e = 1.602 \times 10^{-19} \text{ C}, \quad m_p = 1.67 \times 10^{-27} \text{ kg}, \quad m_e = 9.109 \times 10^{-31} \text{ kg}$$

1. A 75 W lightbulb is attached to an American wall socket at 120 V.

a) (1 point) What is the resistance of the lightbulb?

b) (1 point) How much current flows through the lightbulb?

c) (2 points) You place a second, identical lightbulb in parallel with the first. How long would you need to wait before the lightbulbs have put out 1000 J of energy?

For questions 2 through 4 **fill in the square** next to all correct answers, a given problem may have more or less than one correct answer. Each correctly chosen answer will receive two points. There are **11 correct answers** in this section and only the first **11** filled in answers will be graded. There is no partial credit.

2. Which of the following quantities are scalars?

- a) Position
- b) Displacement
- c) Electric Field
- d) Electric Potential Energy
- e) Magnetic Flux
- f) Electric Force
- g) Resistivity
- h) Electric Potential Field
- i) Induced Current

3. For which of the following situations would the force on the charge be into the page?

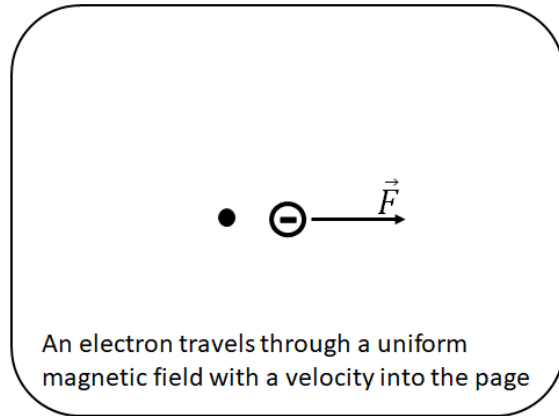
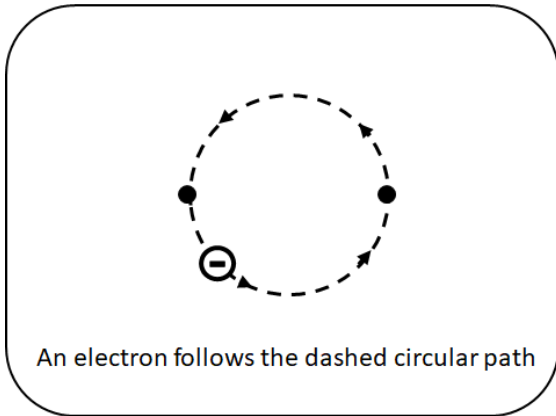
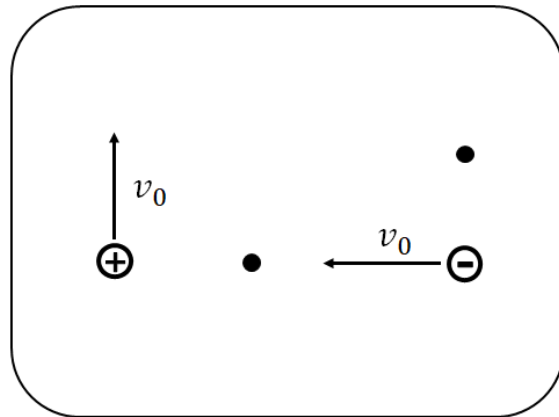
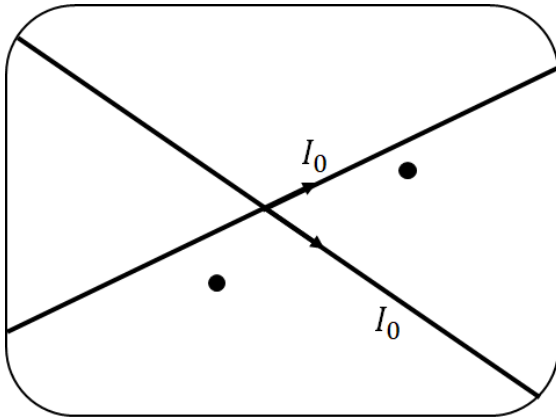
<input type="checkbox"/> a)			
<input type="checkbox"/> b)			
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<input type="checkbox"/> e)			
<input type="checkbox"/> f)			

Circular current loop,
 \vec{A} is in $+x$ direction,
 \vec{v} is in $+y$ direction,
 Charge is opposite center of loop.

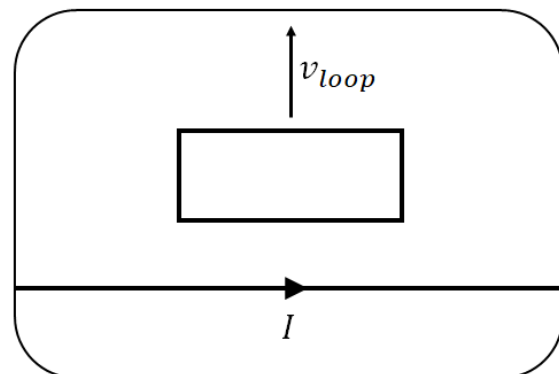
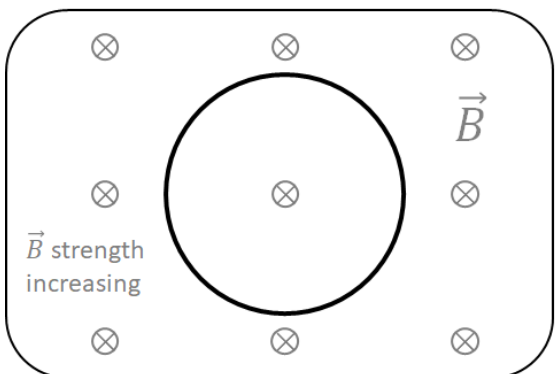
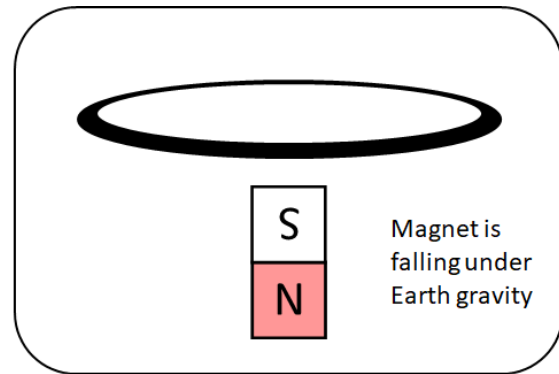
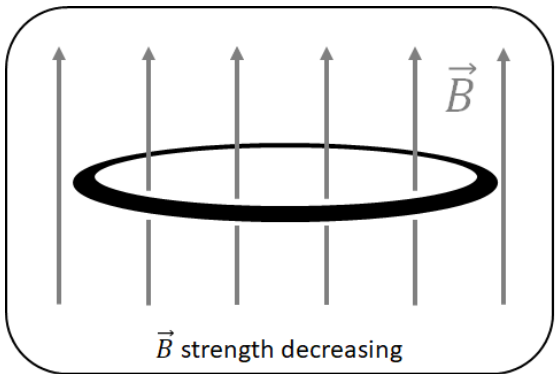
4. Which of the following statements are true?

- a) Light travels faster in materials with lower index of refraction.
- b) Your bathroom mirror creates a virtual image of you when you stand in front of it.
- c) When determining whether constructive or destructive interference is happening, path length difference is *not* important.
- d) The small angle approximation says that the values of Sine and Cosines are approximately equal when angles are smaller than about 10 degrees.
- e) Decreasing the slit separation will spread apart the neighboring fringes created by a double slit apparatus.
- f) When shining white light through a diffraction grating the blue side of each resulting rainbow will appear further from the central maximum than the corresponding red side.

5. (1 point each dot) For each of the following situations, clearly indicate next to each black dot the direction of the magnetic field at the location of that black dot. If it is zero, state $B = 0$.



6. (1 point each wire) For each loop of wire, clearly indicate on the loop the direction of the induced current in that loop.

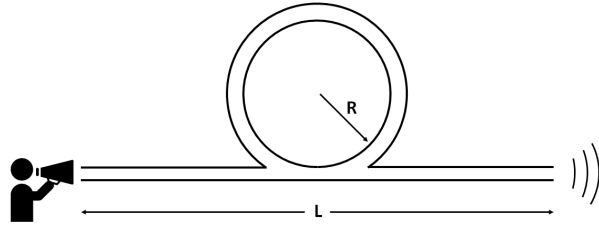


7. Your neighbor's grandpa drives a classic car with an aluminum radio antenna 1.25 meters tall (a thin rod pointed vertically up).

a) (2 points) In which cardinal direction (North, East, South, West) should he drive in order for the top of his antenna to be at a lower electric potential than the bottom of the antenna? (*hint: draw a picture!*)

b) (3 points) The Earth's magnetic field strength is $50 \mu\text{T}$ in Corvallis. How fast would he need to drive to power his 9 V stereo using only the antenna?

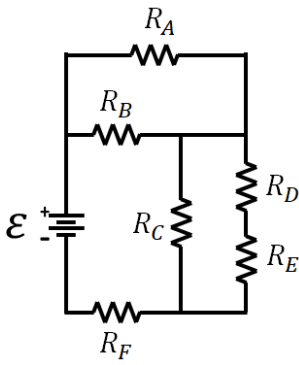
8. (5 points) While practicing your Mongolian overtone singing (the art of singing two distinct frequencies at the same time), you come across an interesting device. The device, pictured below, has a straight open tube joined with a circular open tube. The drawing may not be to scale.



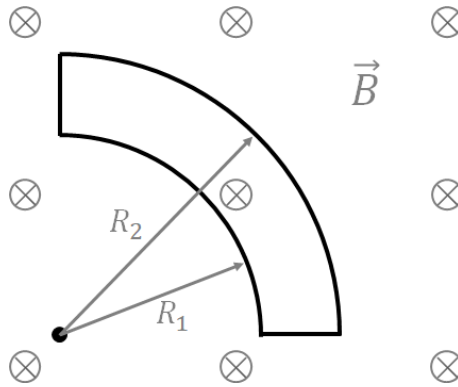
You sing into one end of the tube with a frequency of 400 Hz as well as a frequency of 800 Hz. Out of the other end of the tube, a friend hears one of the frequencies clearly, but not the other. What is the smallest radius for the circular tube which produces this effect?

9. (6 points) Thoroughly explain why a magnet dropped through the middle of a metallic cylinder will accelerate downward at less than 9.8 m/s^2 . You may wish to use a combination of words, graphs, and diagrams.

10. (8 points) A circuit is constructed of six identical 4 ohm resistors as shown. If the battery has a voltage of 9 V, how much current flows through resistor D?



11. A loop of copper wire of resistance $0.0132 \text{ } \Omega/\text{m}$ wire in the following shape is placed into a magnetic field as shown. The magnetic field strength then is decreased at a rate of 0.02 T/s . Let $R_1 = 3 \text{ cm}$, and $R_2 = 5 \text{ cm}$.



a) (2 points) Clearly indicate on the figure which direction the induced current will flow in each of the four sections of the loop.

b) (6 points) What is the magnitude of the induced current in the loop?

12. (7 points) A proton is initially at the origin and travelling in the $-z$ direction at a speed v_0 . A magnetic field of magnitude 0.3 T is directed in the $+y$ direction. An electric field of magnitude 1300 N/C is also directed in the $+y$ direction. At what y coordinate is the proton when it completes its first revolution? (*when it returns to the same (x,z) position*)