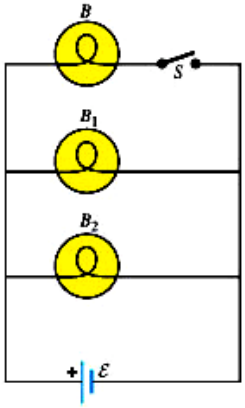
Physics 180B Name _____
Final Test - 120 Points

You need to do

1. Three equal point charges are held in place as shown in the figure. If F_1 is the force on q due to Q_1 and F_2 is the force on q due to Q_2, how do F_1 and F_2 compare? (6 points)

a. $4F_1 = F_2$ b, $1/16F_1 = F_2$ c. $3F_1 = F_2$ d. $1/9F_1 = F_2$

2. A battery with no internal resistance is connected across identical light bulbs as shown in the figure. When you close the switch S, bulbs B_1 and B_2 will be



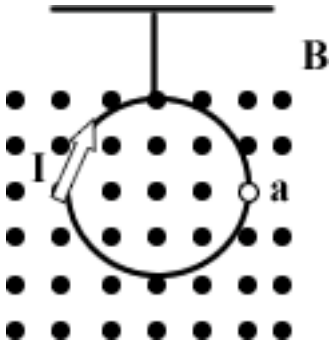
(3 points)

a. dimmer than before
b. brighter than before
c. just as bright as before

(3 points)

a. because the current will increase through each branch.
b. because the Voltage will remain the same over each branch.
c. because the Voltage will decrease across each branch.

3. A light circular wire suspended by a thin silk thread in a uniform magnetic field carries a current in the direction shown in the figure. The magnetic field is perpendicular to the plane of the paper, and the wire is held at rest in that plane. If the wire is suddenly released so that it is free to rotate,



(3 Points)

a. it will not rotate..
b. it will rotate so that point *a* goes out of the paper.
c. it will rotate so that point *a* goes into the paper

(3 Points)

a. the force on the ring due to the mag-field is always inward.
b. the force on the ring due to the mag-field is always outward.
c. there is no force on the ring due to the mag field.

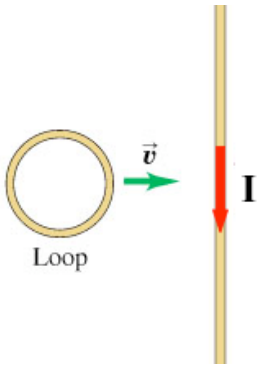
4. An electrical current is suddenly sent through a metal helical spring. The current will cause the coils of the spring to (6 Points)

a. push apart, elongating the spring because the current in each loop is parallel to each other causing a repulsion between the windings of the coil.
b. push apart, elongating the spring because the current in each loop is anti-parallel to each other causing a repulsion between the windings of the coil.
c. pull together, compressing the spring because the current in each loop is parallel to each other causing an attraction between the windings of the coil.
d. pull together, compressing the spring because the current in each loop is anti-parallel to each other causing an attraction between the windings of the coil.
e. remain the same, since the current will have no effect on the spring

5. A metal loop moves at constant velocity toward a long wire carrying a steady current I, The current induced in the loop is directed (6 points)

a. ecause the movement toward the current wire is producing an **increasing magnetic flux** through the loop which means the induced magnetic field in the loop must oppose this change. So, the induced current will produce a magnetic field through the loop in the **opposite direction** of the external magnetic flux. So the induced current will go in a CCW direction.

b. Because the movement toward the wire is producing a **decreasing magnetic flux** through the loop which means the induced magnetic field in the loop must oppose this change. So, the induced current will produce a magnetic field through the loop in the **same direction** of the external magnetic flux. So, the induced current will go in a CCW direction.

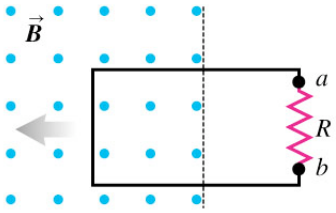


c. Because the movement toward the wire is producing an **increasing magnetic flux** through the loop which means the induced magnetic field in the loop must oppose this change. So, the induced current will produce a magnetic field through the loop in the **opposite direction** of the external magnetic flux. So the induced current will go in a CW direction.

d. Because the movement toward the wire is producing a **decreasing magnetic flux** through the loop which means the induced magnetic field in the loop must oppose this change. So, the induced current will produce a magnetic field through the loop in the **same direction** of the external magnetic flux. So, the induced current will go in a CW direction.

e. Zero, the magnetic flux is not changing.

6. A metal loop is being pushed at a constant velocity into a uniform magnetic field, as shown in the figure, but is only partway into the field. As a result of this motion, (6 points)



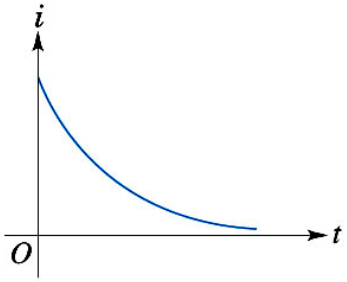
a. Ends *a* and *b* are at the same potential.
b. End *a* of the resistor R is at a higher potential than end *b.*
c. End *b* of the resistor R is at a higher potential than end *a.*
d. There is no potential across R due to no changing flux.

7. The graph in the figure shows the current in a resistor-capacitor circuit as a function of time. From this graph, we can tell that (3 points)

a. the capacitor must be discharging.
b. the capacitor must be charging.
c. the capacitor could be either charging or discharging, but we cannot tell which it is.

(3 points)

Which statement(s) are correct about the circuit?



a. The current thru the circuit is a maximum at t = 0.
b. The capacitor is completely uncharged at t = infinity
c. The capacitor is completely charged at t = infinity
d. The current thru the circuit is a minimum at t = 0.

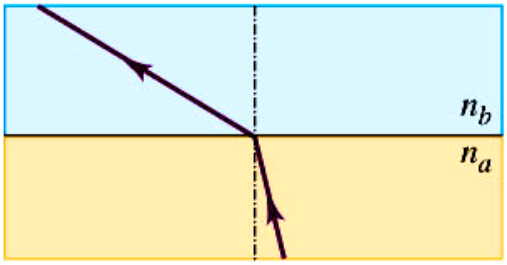
8. A ray of light going from one material into another follows the path shown in the figure. What can you conclude about the relative indexes of refraction of these two materials? (6 points)

a. $n_a \geq n_b$

b. $n_a \leq n_b$

c. $n_a < n_b$

d. $n_a > n_b$



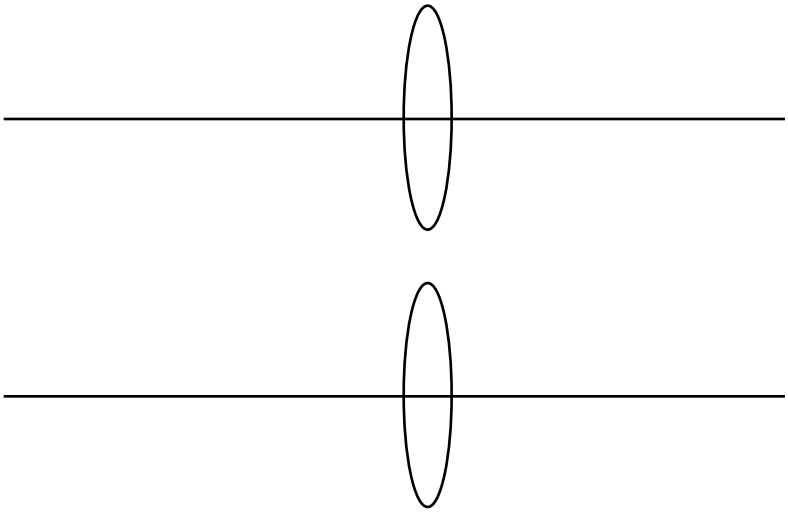
9. Light travels from water (with index of refraction 1.33) into air (index of refraction 1.00). Which of the following statements about this light is true? (There may be more than one correct choice.) (6 points)

a. The light has the same wavelength in the air as it does in the water.
b. The light has the same speed in the air as in the water.
c. The light has the same frequency in the air as it does in the water.
d. The light travels faster in the air than in the water.
e. The wavelength of the light in the air is greater than the wavelength in the water.

10. An object is beyond the focal point of a converging lens. If you want to bring its image closer to the lens, you should move the object (3 points)

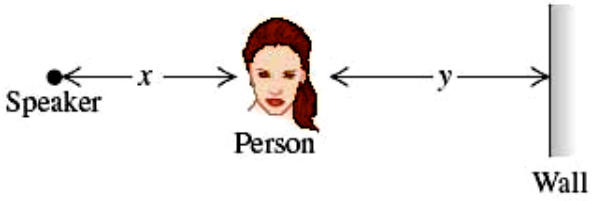
a. away from the lens.
b. toward the lens.
c. to the focal point of the lens.

show it for (3 points)



11. A person is standing at a distance x from a stereo speaker that is emitting a continuous tone. She hears the sound directly from the speaker, as well as the sound reflected from a wall a distance $y\,(x > y)$ away. The path difference between these two sound waves as they reach the listener is

Show it for (3 points)



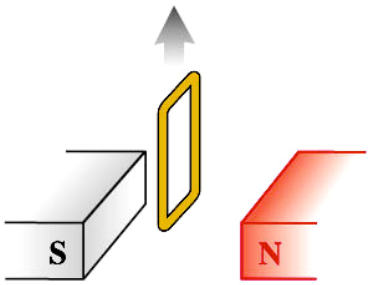
(3 points)

a. $y - x$ b. $2y - x$ c. $x + y$ d. $2y$ e. $2x$

12. A square loop of wire is pulled upward out of the space between the poles of a magnet, as shown in the figure. As this is done, the current induced in this loop,
as viewed from the N pole of the magnet, will be directed

(3 points)

a. clockwise.
b. counterclockwise.
c. zero.



(prove it on the diagram for 3 points)

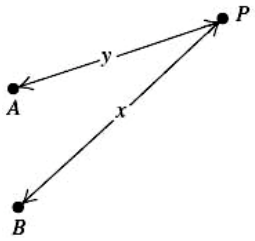
13. At point P, the path difference for waves from these two sources is (3 points)

a. $x - y$

b. $\dfrac{x - y}{2}$

c. $x + y$

d. $\dfrac{x + y}{2}$



if the sources A and B in the figure are emitting waves of wavelength lambda that are in phase with each other, *constructive* interference will occur at point P if (there may be more than one correct choice): (3 points)

a. $x - y = 2\lambda$ b. $x + y = \lambda$

c. $x = y$ d. $x - y = 5\lambda$

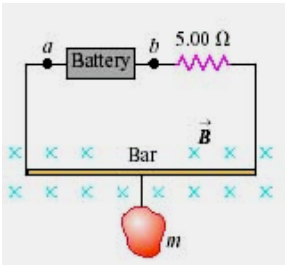
Answer only 5 problems below. Cross out 2 problems. No extra credit, please.

1. Two small spheres spaced 9.5 cm apart have equal charge. How many excess electrons must be present on each sphere if the magnitude of the force of repulsion between them is 5.50×10^{-21} N?
(12 points you need to show work)

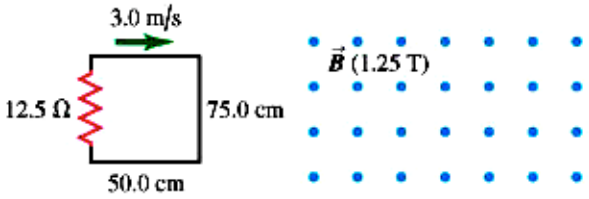
2. Two large metal parallel plates carry opposite charges of equal magnitude. They are separated by 45.0 mm, and the potential difference between them is 480 V. What is the magnitude of the electric field (assumed to be uniform) in the region between the plates? What is the magnitude of the force this field exerts on a particle with charge 4.60 nC? (12 points you need to show work)

3. An 1800 W toaster, a 1400 W electric frying pan, and a 75.0 W lamp are plugged into the same electrical outlet in a 20.0 A, 120 V circuit. (*Note:* When plugged into the same outlet, the three devices are in parallel with each other across the 120 V outlet.) What current is drawn by the toaster? What current is drawn by the electric frying pan? What current is drawn by the lamp? Will this combination blow the circuit breaker? (12 points you need to show work)

4. The circuit shown in the figure is used to make a magnetic balance to weigh objects. The mass m to be measured is hung from the center of the bar, which is in a uniform magnetic field of 1.50 T directed into the plane of the figure. The battery voltage can be adjusted to vary the current in the circuit. The horizontal bar is 60.0 cm long and is made of extremely lightweight material, so its mass can be neglected. It is connected to the battery by thin vertical wires that can support no appreciable tension; all the weight of the mass m is supported by the magnetic force on the bar. A 5.00 ohms resistor is in series with the bar, and the resistance of the rest of the circuit is negligibly small. Which point, a or b, should be the positive terminal of the battery? If the maximum terminal voltage of the battery is 175 V, what is the greatest mass m that this instrument can measure? (12 points you need to show work) (12 points you need to show work)



5. A rectangular circuit is moved at a constant velocity of 3.00 m/s into, through, and then out of a uniform 1.25 T magnetic field, as shown in the figure. The magnetic field region is considerably wider than 50.0 cm. Find the direction (clockwise or counterclockwise) of the current induced in the circuit as it is going into the magnetic field (the first case), totally within the magnetic field but still moving (the second case), and moving out of the field (the third case). Show it on the diagram. Find the magnitude of the current induced in the circuit as it is going into the magnetic field . Find the magnitude of the current induced in the circuit as it is totally within the magnetic field but still moving . Find the magnitude of the current induced in the circuit as it is moving out of the field . (12 points you need to show work)



6. The critical angle for total internal reflection at a liquid-air interface is 42.5°. If a ray of light traveling in the liquid has an angle of incidence of 35.0° at the interface with respect to the normal, what angle does the refracted ray in the air make with the normal? If a ray of light traveling in air has an angle of incidence of 35.0° at the interface with respect to the normal, what angle does the refracted ray in the liquid make with the normal? (12 points you need to show work)

7. When two lenses are used in combination, the first one forms an image that then serves as the object for the second lens. The magnification of the combination is the ratio of the height of the final image to the height of the object. A 1.20 cm-tall object is 50.0 cm to the left of a lens of focal length of magnitude 40.0 cm. A second lens, this one having a focal length of magnitude 60.0 cm, is located 300 cm to the right of the first lens along the same optic axis. Find the location and height of the image (call it I_1) formed by the lens with a focal length of 40.0 cm if the first lens is *converging* and the second lens is a *diverging*. I_1 is now the object for the second lens. Find the location and height of the image produced by the second lens. (12 points you need to show work)

8. Two identical audio speakers connected to the same amplifier produce in-phase sound waves with a single frequency that can be varied between 340 and 600 Hz. The speed of sound is 340 m/s. You find that where you are standing, you hear minimum-intensity sound. Explain why you hear minimum-intensity sound. If one of the speakers is moved 38.8 cm toward you, the sound you hear has maximum intensity. What is the frequency of the sound? How much closer to you from the position in part B must the speaker be moved to the next position where you hear maximum intensity? (12 points you need to show work)