

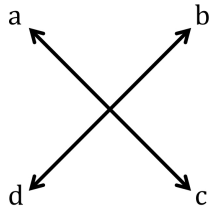
NAME : _____

SID # : _____

1. Two wires parallel to the z-axis carry equal currents in directions shown. ($|I_1| = |I_2| = I$). Wire #1 is located at $(-d, 0)$ and wire #2 is at $(0, -d)$. (The z-axis is perpendicular to the page).

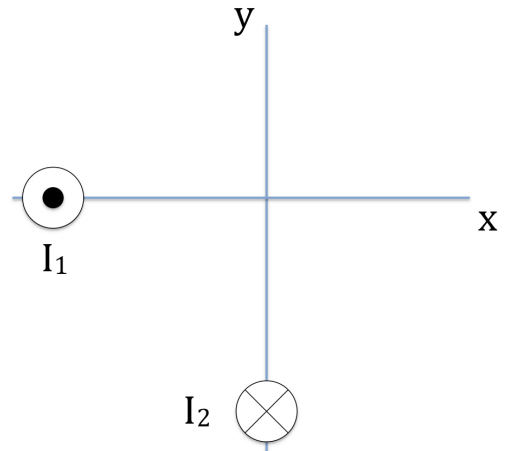
A) M.C. (2 pts)

What is the direction of the force on wire #2?



f) into page

e) out of page



B) (13 pts)

Determine at what location (or locations) you can place a third wire, also parallel to the z-axis, with $|I_3| = 3I$ such that the net magnetic field at the origin is zero. For any location you find, draw a clear diagram indicating your answer.

MC Answer

NAME : _____

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2. Consider an LC circuit with an open switch. The 1F capacitor starts with an initial charge of 6C . At $t=0$ the switch is closed. At some instant later, the charge has reduced to 2C and the current leaving the capacitor is 4A .

A) (3 pts) Find the voltage across the inductor just after you close the switch.

B) (10 pts) Find the maximum value the current reaches in the LC circuit.

C) M.C. (2 pts)

If the initial charge on the capacitor is doubled, the time it takes for the capacitor to fully discharge for the first time would

- a) Increase by a factor of 4
- b) Increase by a factor of 2
- c) Stay the same
- d) Decrease by a factor of 2
- e) Decrease by a factor of 4

MC Answer

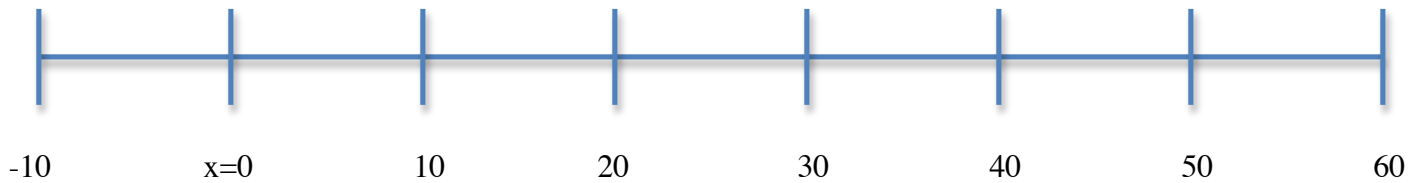
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3. You are studying an alien eyeball. It is 10 cm in diameter (retina to lens) and has a focal length of +8 cm. Take the retina to be at $x = 0$ cm and the alien is looking toward the +x axis. NOTE: Unlike your eye, the alien can't adjust its focal length. (Yay for humans!!!)

- A) (5 pts) What object position (i.e. x-location) will the alien see most clearly?
- B) (4 pts) Show with a qualitatively accurate ray tracing diagram that an object at $x = 25$ cm will appear blurry to the alien. Indicate what makes it "blurry".
- C) (11 pts) Assuming the alien wants to read a book held at $x = 25$ cm, what focal length would you prescribe for the alien's reading glasses? Assume the glasses are 5 cm in front of the eyeball. If the letters in the book are 1 cm high, how big are the letters on the alien's retina? Are they the same orientation or inverted compared to the book?

Draw answer for B) here



NAME : _____

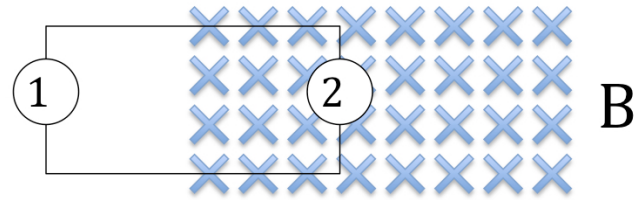
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4. You hold a rectangular loop of width, w , and height, h , half embedded in a region of magnetic field directed into the page as shown. The magnetic field (in Tesla) changes in magnitude according to $B(t) = 6 - 3t$. The loop has two bulbs each with resistance R as shown.

A) M.C. (2 pts)

Which bulb will light up?

- a) Bulb 1
- b) Bulb 2
- c) Both
- d) Neither



B) (18 pts)

Find the force (magnitude and direction) that you must exert to hold the loop in place at time $t = 1$ sec. (Be sure to explain how you got your direction). Is the force you must exert constant or changing in time?

MC Answer

NAME : _____

SID # : _____

5. You have a laser that emits light whose E-field oscillates vertically. The laser has power P and its beam has diameter d . You have three polarizers with transmission/polarization axes given (A – horizontal axis, B – vertical axis, C – axis at θ degrees to the horizontal)

A) M.C. (2 pts)

You shine the laser through all three polarizers. Which order of polarizers will transmit the most light? (Order listed is first to last)

- a) ABC b) ACB c) BAC d) BCA e) CAB f) CBA g) it depends on θ

B) (8 pts)

If instead you only use polarizer C, find the maximum E-field and maximum B-field of the light emerging from polarizer C

MC Answer

NAME : _____

SID # : _____

6. In this problem you can consider $n_{\text{air}} = 1$. Also $n_{\text{air}} < n_{\text{liquid}} < n_{\text{glass}}$

A) (5 pts) A layer of liquid is on top of a mirror. A laser shines light on the liquid at 30 degrees above the horizontal surface of the liquid. Show on a diagram a qualitatively accurate path the light takes and find the **numerical angle** (measured to the normal) when it reemerges into the air.

air



liquid



B) (5 pts) If instead, the layer of liquid is on top of a piece of glass. A laser shines light on the liquid at 30 degrees above horizontal the surface of the liquid. Show on a diagram a qualitatively accurate path the light takes and find the **numerical angle** (measured to the normal) when it reemerges into the air. **Only consider transmitted light in this case.**

air



liquid



glass



air