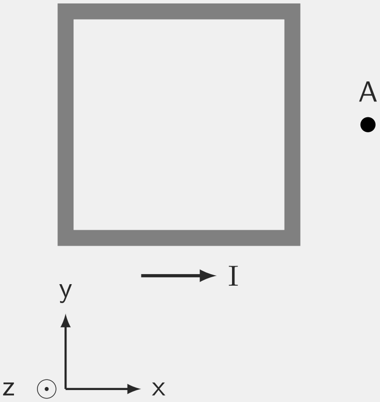
Announcements

- Homework
  - Webwork 12 due tonight!
  - Video HW this weekend! Make sure your question fulfills the objective!
- Physics Friday!
  - Physics Tea today at 3pm
  - Don't think we have a speaker at 3:30, but I have board games if anyone wants to play those
- Polling: `rembold-class.ddns.net`

Short Diversion

- InventOR



Given that the current in the square loop to the left is moving in a counter-clockwise fashion, in what direction is the magnetic field at point A pointing?

A. $\hat{\mathbf{z}}$
B. $-\hat{\mathbf{z}}$
C. $-\hat{\mathbf{x}}$
D. $\hat{\mathbf{y}}$

Solution: $-\hat{\mathbf{z}}$ Not convinced? I made an animation that you can view here to see this.

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- The Solenoid!
  - A series of traveling loops
  - Imagine wrapping a rod tightly with non-overlapping wire
  - For a long solenoid, we get an approximately constant magnetic field in the center (and far from the ends):

    $$B \approx \mu_0 \frac{N\mathrm{I}}{L}$$

    where N is the number of loops and L the length of the solenoid!

Solenoid Example

Suppose we found a power supply to drive a 1 A current through our demo solenoid in the front of the class. What magnetic field would be expect to measure in the center?

Solution: 1.508 mT

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We measured 12 loops per 10 mm.

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- Earth as a Magnet
  - Field follows that of a dipole
  - But North Pole is magnetic “south pole”!
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  - Chopping up dipoles just gets you more dipoles...
- Spinning and orbits at the molecular level make tiny currents
  - Results in tiny magnetic dipoles
  - Key is getting them to line up with one another
  - Generally only happens in ferromagnetic materials like iron, nickel, or cobalt

Upcoming:

Our Current Understanding

Goals

- We want to understand how a circuit is functioning on the microscopic level:
  - What is in equilibrium, what is conserved
  - How current behaves, splits, turns, etc
  - Relate all of this to our momentum and energy principles
- What do batteries even really do?

A Lack of Equilibrium

- Already saw in lab:
  - For circuit with light on, $\Delta V \neq 0$
  - So not in equilibrium!
- Light brightness doesn't change appreciably over time
  - The amount we are "out of equilibrium" doesn't change much
  - We tend to call this a steady state

Warning!

Steady state does NOT imply Equilibrium!

The Ebbs and Flows of Current

Consider the below circuit. You've connected all the wires so that *the light is shining* brightly. How do you think the current will compare section B vs in section A?

A. $I_B > I_A$
B. $I_B = I_A$
C. $I_B < I_A$
D. $I_B = 0$