Circle your lab day and time.

Your name: ______________	Tue	Tue	Tue	Wed	Thu	Thu	Fri
TA name: ______________	10-12	12-2	2-4	12-2	10-12	12-2	12-2

Written HW 4: Magnetic Accelerators and Fields (due Fri, Oct 19, 2012 at 2 PM)

Turn in this homework in the Homework Cabinet at the entrance of the HelpRoom, Duane G2B90. Please STAPLE, and **put your name & TA name at the top of every page!**
As i*n all written homework, you will be graded on the clarity and completeness of your answer.*

Part 1. Magnetic fields:

First are a few questions trying to build on your experience with electric fields from dipoles to work out some details about magnetic fields from bar magnets.

a) i) Explain in words how the *direction* of the magnetic field at every point is related to the *magnetic field lines* drawn in pictures.

ii) Explain how the *strength* of the magnetic field at every point is related to the *magnetic field lines* in pictures.

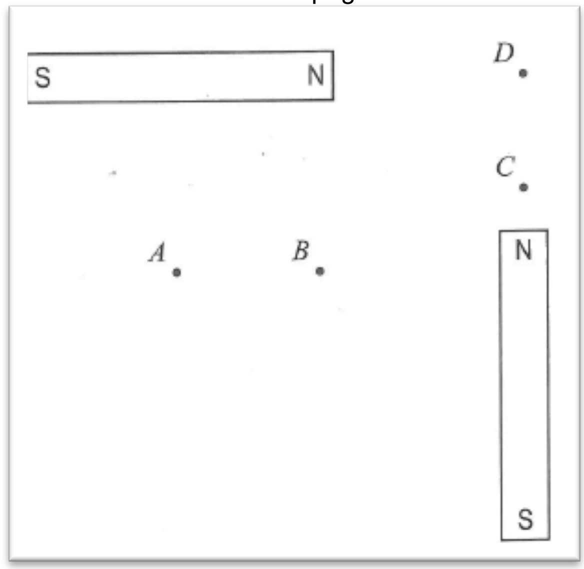
b) Carefully draw *magnetic field lines* for the simple bar magnet shown to the right. (For now, ignore the points labeled A, B, and C) Be sure to draw the field lines so they include the rules from part a, i.e. to show the strength and direction of the field lines - both inside and outside the magnet.)

c) Based on the magnetic field lines you have drawn, please rank the field strengths for the three points labeled A, B, and C in the diagram, from strongest to weakest. Briefly, why did you rank them like this?

d) Now two identical magnets are placed as shown. Using different colored pens, sketch the approximate magnetic field vectors at the four labeled points for:

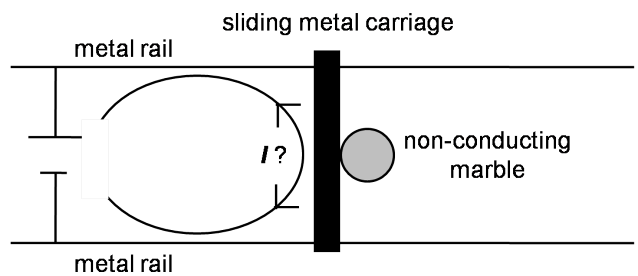
- just the horizontal top magnet,
- just the vertical lower magnet, and
- when both are present.

Explain in words how you determined the field vectors for the case when both magnets are present.



Part 2: The Rail Gun.

Your niece is working on a high-school science-fair project. It's an electrical device, based on magnetic concepts, designed to launch a non-conducting marble.
As shown in the figure, a battery is connected to two metal wires (rails) which are bridged by a sliding conducting rod (the "carriage"). This completes a current-carrying circuit. (The rails continue far off to the right, but do not connect to each other anywhere)



a) Assume that the circuit is powered by a 12 V car battery. All the resistance in the circuit comes primarily from the sliding joint between the carriage and the rails, and is in total a constant 0.5 Ω. The rails are 50 cm apart. How much current runs around the circuit? Indicate the current direction on the diagram.

b) Indicate the direction of the magnetic field in the region between the two rails on the diagram. Using our simple formula for the magnetic field from a long wire (Giancoli section 20-5), what is the magnitude of the magnetic field exactly halfway between the rails?

c) What is the magnitude of the magnetic force on the sliding metal carriage? Indicate the direction of the force on the diagram. (Approximate the magnetic field as being **uniform** in the vicinity of the carriage, with the magnitude and direction that you calculated in part b).

d) Your niece wants to launch a 100 g marble. The mass of the sliding carriage is 1 kg. What is the acceleration of the marble? What is the final velocity of the marble, if the slider accelerates it over a distance of 1 m (assume constant acceleration and neglect friction and gravity)?

e) What do you think of this project? Would you recommend your niece pursue it? Why/why not? How could you improve the set-up (i.e. achieve a higher acceleration of the marble)? Explain your reasoning.