Name:

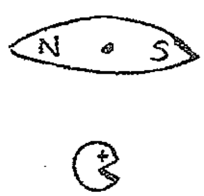
Group Members:

Physics Tutorial #7:

Magnetic Fields

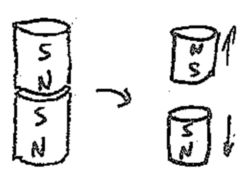
Question 1

a) In the picture, Pac-Man is positively charged. Does the compass needle rotate? If so, in which direction? If not, why not?



No: magnetic poles don't carry any electric charge, so there is no preference for S vs N to be attracted to Pac-Man.

b) Two metal cylinders are observed to attract one another. Without using any other object, is it possible to tell whether *both* are permanent magnets?

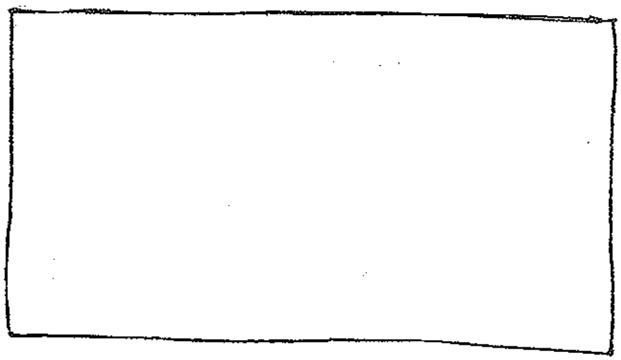


If both are permanent magnets, they will repel if one of them is flipped.

if you think of a solution, try it out with the metal cylinders at the side of the room!

Question 2

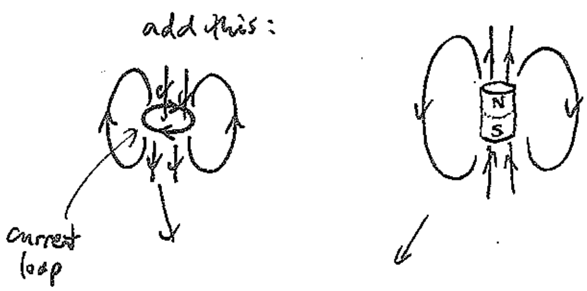
Help map out the mystery magnetic field! At the side of the room, you will find Mark's Magical Magnetic Mat. Determine the direction of the magnetic field at a point (or two) on the mat and draw a vector arrow at this point to represent the direction. Come back later to see all the arrows, and indicate on the figure below what you think is causing these magnetic fields.



Question 3

The diagram below shows a permanent magnet. Can you draw a configuration of current-carrying wire that will (almost) cancel out the magnetic field from this magnet? If not, why not?

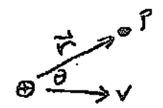
(show the direction of the current)



a current loop has a mag. field like a permanent magnet. Thus, if we add a current loop with a field similar to a magnet of the opposite orientation, we can nearly cancel the field.

net field ≈ 0 if we choose I correctly.

* Field of a point charge at p:

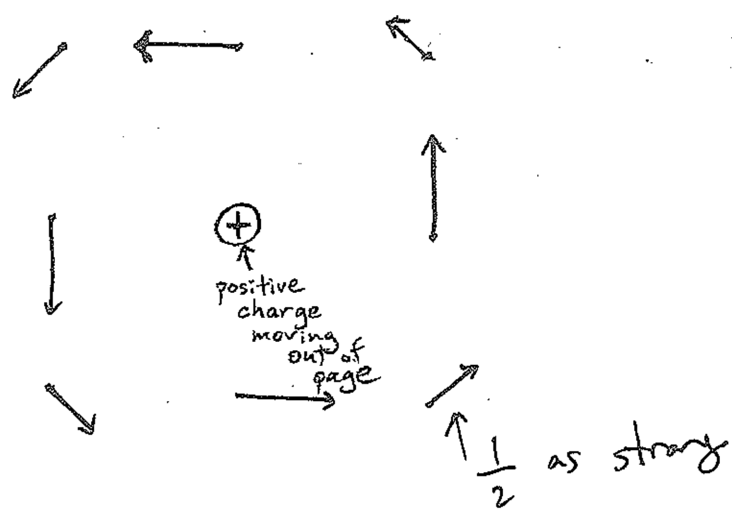


$$\vec{B} = \frac{\mu_0}{4\pi} \frac{q}{r^3} \vec{v} \times \vec{r} \rightarrow \text{magnitude } |\vec{B}| = \frac{\mu_0}{4\pi} \frac{q}{r^2} v \sin\theta$$

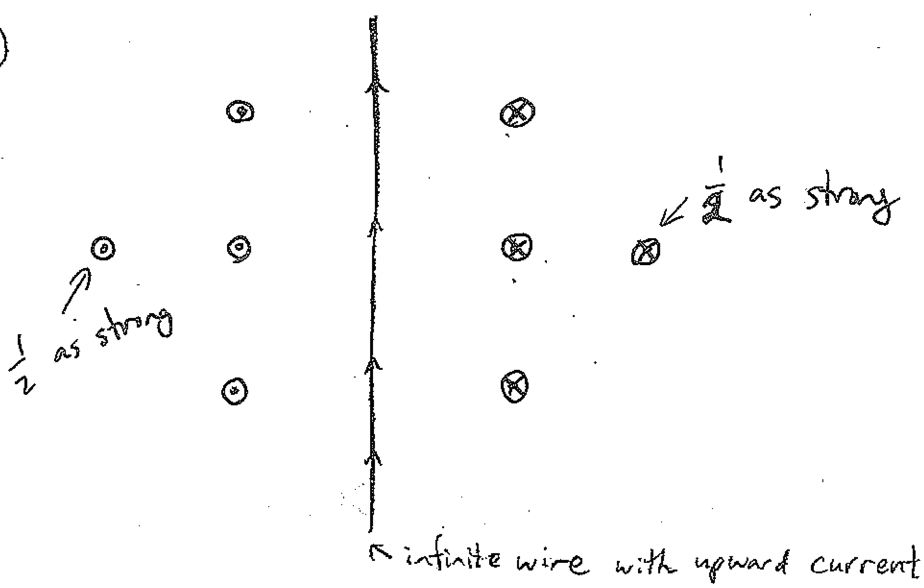
Question 4

For the two situations below, draw vector arrows at each dot to represent the strength *and* the relative magnitude of the magnetic field at that point. (use ⊗ for into page and ⊙ for out of page)
- in these cases, use a number to indicate relative strength.

a)



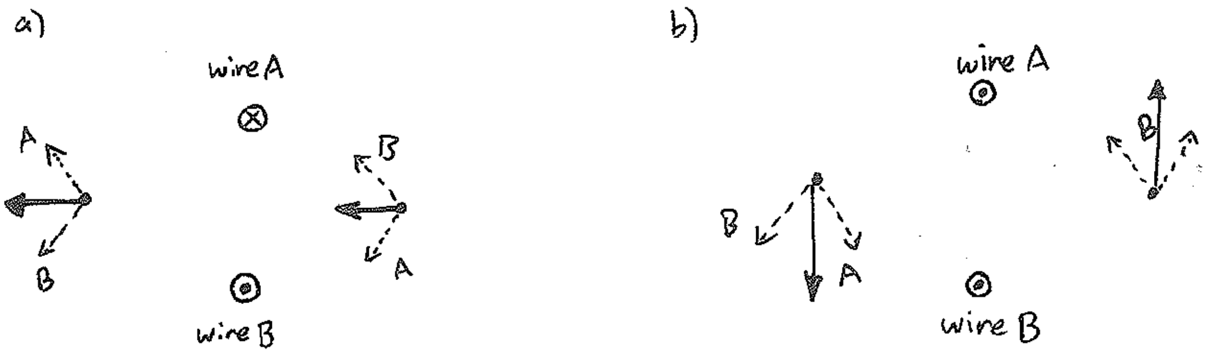
b)



Field from a wire: magnitude $|\vec{B}| = \frac{\mu_0}{2\pi} \frac{I}{d}$ ← distance to wire

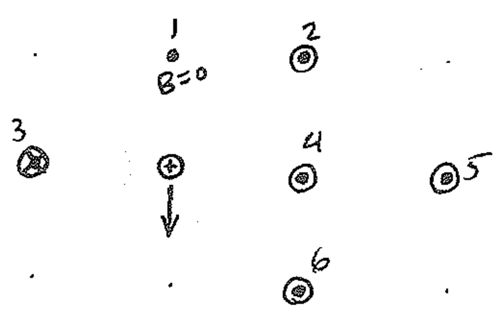
Question 5

The figures below each show two long current-carrying wires pointing into or out of the page. At each dot, show the magnetic field vectors from the individual wires (use dotted vectors labeled A and B) and the net magnetic field (use a solid vector).



Question 6

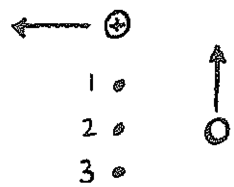
A proton moves toward the bottom of the page. Show the direction of the magnetic field at each of the numbered points (or say B=0). Rank the fields B_1 to B_6 from strongest to weakest.



$$B_3 = B_4 > B_2 = B_6 > B_5 > B_1$$

Question 7

In the picture, the magnetic field at point 2 is zero.



a) Is the unlabeled charge positive or negative? Explain.

Field from ⊕ : out of page

Field from O : must be into page at 2

∴ - ve charge

b) What is the direction of the magnetic field at point 1? Explain.

closer to ⊕

field out of page from ⊕ is larger in magnitude than field into page from ⊖

∴ out of page

c) What is the direction of the magnetic field at point 3? Explain.

closer to ⊖

field out of page from ⊕ is smaller in magnitude than field into page from ⊖

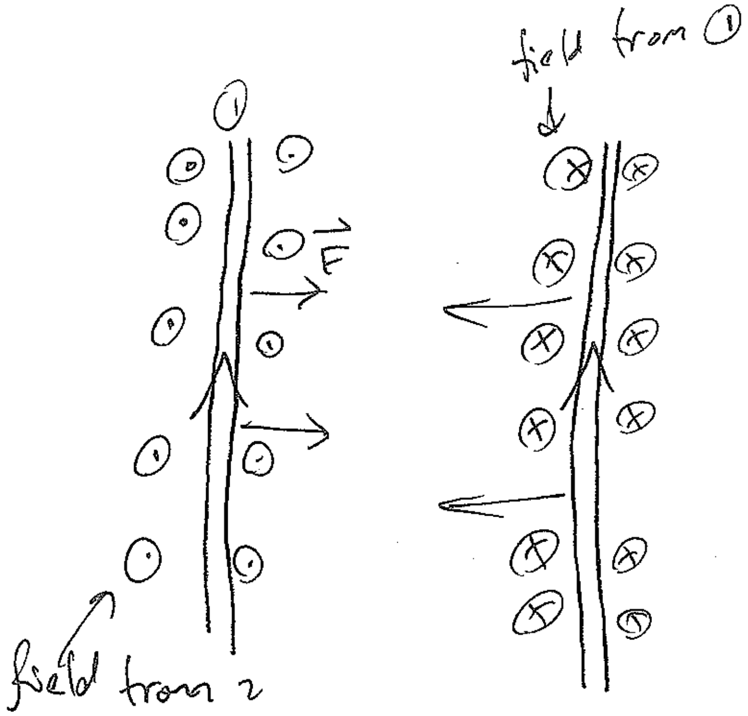
∴ into page.

Question 8

Why does the Earth have a magnetic field? What possible explanations can you come up with?

Question 9:

Imagine two wires running parallel next to each other.



What, if anything, happens to the wires when a current I is made to flow upwards in each wire? Explain.

$$\vec{F}_{on\ 2} = I\vec{\ell} \times \vec{B}_1$$

($\vec{\ell}$: up; $\vec{B}_1$: into page)

$$= \text{leftward}$$

$$\vec{F}_{on\ 1} = I\vec{\ell} \times \vec{B}_2 = \text{to right.}$$

∴ wires will attract