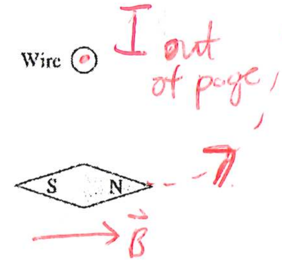
1.

The figure shows a wire directed into the page and a nearby compass needle. Is the wire's current going into the page or coming out of the page? Explain.



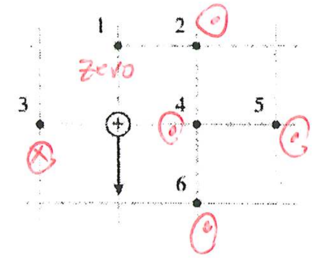

$\vec{B}$ is ccw around wire.
By RHR I is out of page.

2.

A positively charged particle moves toward the bottom of the page.

a. At each of the six number points, show the direction of the magnetic field or, if appropriate, write $\vec{B} = \vec{0}$.

b. Rank in order, from strongest to weakest, the magnetic field strengths $B_1$ to $B_6$ at these points.




Order:

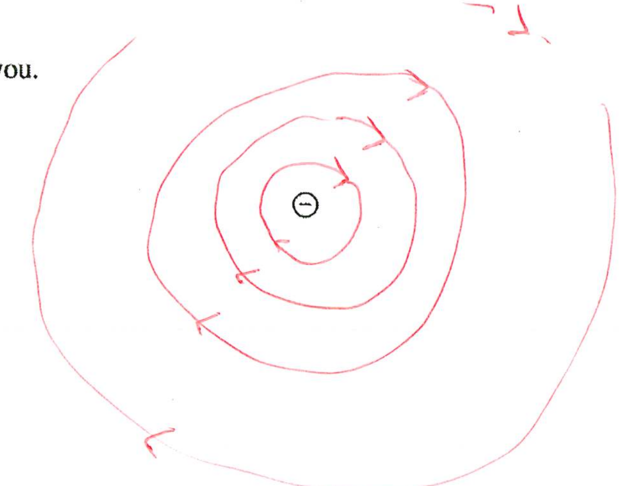
Explanation:

$$\vec{B} = \frac{q\vec{v} \times \hat{r}}{r^2}$$

(b) $|\vec{B}| = \frac{qv \sin\theta}{r^2}$ $B_3 = B_4 > B_2 = B_6 > B_5 > B_1$

3.

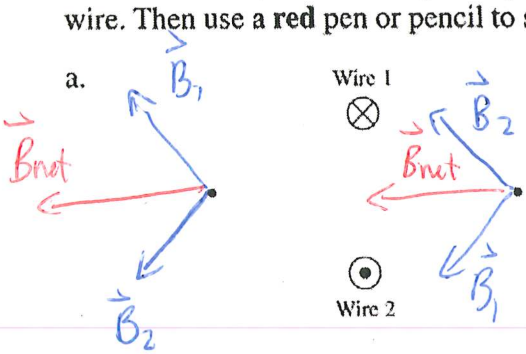
The negative charge is moving out of the page, coming toward you. Draw the magnetic field lines in the plane of the page.



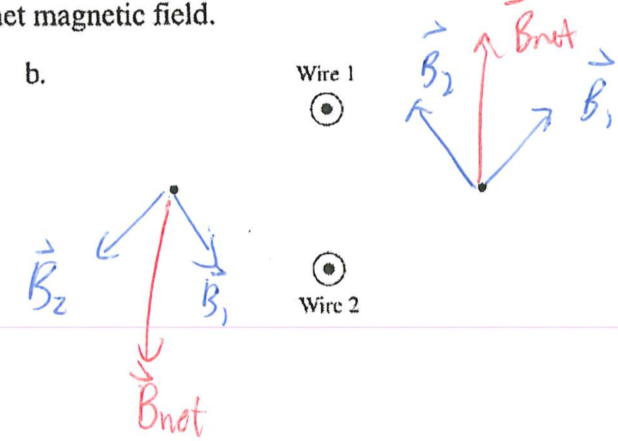
Note: q is negative.

4\. Each figure below shows two long straight wires carrying equal currents into or out of the page. At each of the dots, use a **black** pen or pencil to show and label the magnetic fields $\vec{B}_1$ and $\vec{B}_2$ due to each wire. Then use a **red** pen or pencil to show the net magnetic field.

a.



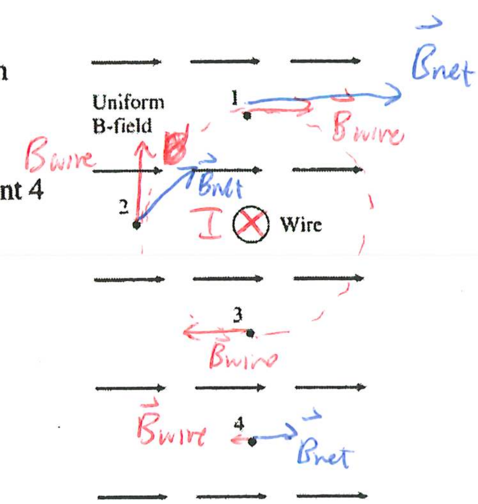

b.




5\. A long straight wire, perpendicular to the page, passes through a uniform magnetic field. The *net* magnetic field at point 3 is zero.

a. On the figure, show the direction of the current in the wire.

b. Points 1 and 2 are the same distance from the wire as point 3, and point 4 is twice as distant. Construct vector diagrams at points 1, 2, and 4 to determine the net magnetic field at each point.

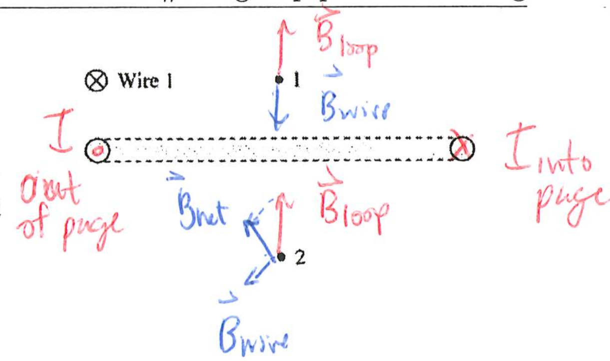



(a) $\vec{B}_{wire}$ ccw. ∴ I into page

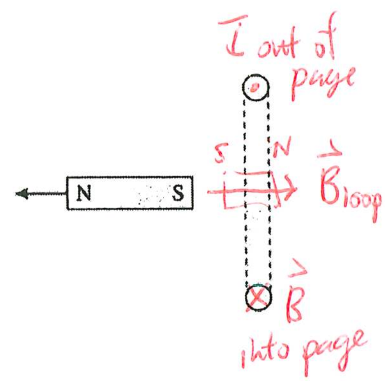
6. A long straight wire passes above one edge of a current loop. Both are perpendicular to the page. $\vec{B}_1 = \vec{0}$ at point 1.

a. On the figure, show the direction of the current in the loop.

b. Use a vector diagram to determine the net magnetic field at point 2.

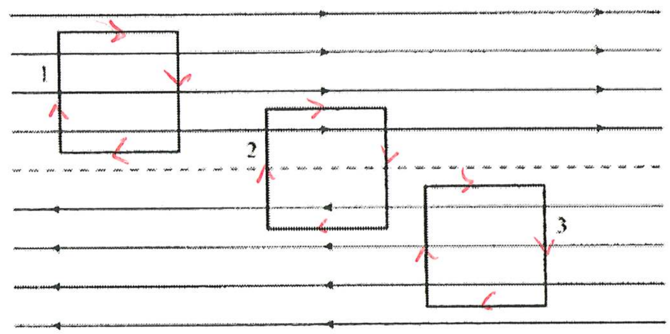



7. The current loop exerts a repulsive force on the bar magnet. On the figure, show the direction of the current in the loop. Explain.



8.

The magnetic field above the dotted line is $\vec{B} = (2\text{ T, right})$. Below the dotted line the field is $\vec{B} = (2\text{ T, left})$. Each closed loop is $1\text{ m} \times 1\text{ m}$. Let's evaluate the line integral of $\vec{B}$ around each of these closed loops by breaking the integration into four steps. We'll go around the loop in a *clockwise* direction. Pay careful attention to signs.




| | Loop 1 | Loop 2 | Loop 3 |
|---|---|---|---|
| $\int \vec{B} \cdot d\vec{s}$ along left edge | $\vec{B} \cdot d\vec{s} = 0$ | 0 | 0   $\vec{B} \perp d\vec{s}$ |
| $\int \vec{B} \cdot d\vec{s}$ along top | $+2\text{ T}\cdot\text{m}$ | $+2\text{ T}\cdot\text{m}$ | $-2\text{ T}\cdot\text{m}$ |
| $\int \vec{B} \cdot d\vec{s}$ along right edge | 0 | 0 | 0   $\vec{B} \perp d\vec{s}$ |
| $\int \vec{B} \cdot d\vec{s}$ along bottom | $-2\text{ T}\cdot\text{m}$ | $+2\text{ T}\cdot\text{m}$ | $+2\text{ T}\cdot\text{m}$ |

The line integral *around* the loop is simply the sum of these four separate integrals:

| | Loop 1 | Loop 2 | Loop 3 |
|---|---|---|---|
| $\oint \vec{B} \cdot d\vec{s}$ around the loop | 0 | $+4\text{ T}\cdot\text{m}$ | 0 |

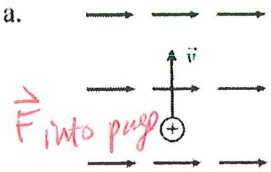
9. A solenoid with one layer of turns produces the magnetic field strength you need for an experiment when the current in the coil is 3 A. Unfortunately, this amount of current overheats the coil. You've determined that a current of 1 A would be more appropriate. How many additional layers of turns must you add to the solenoid to maintain the magnetic field strength? Explain.

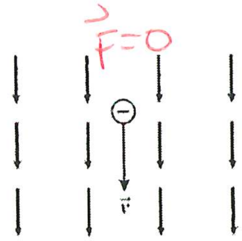
$B = \mu_0 \frac{N}{L} I$

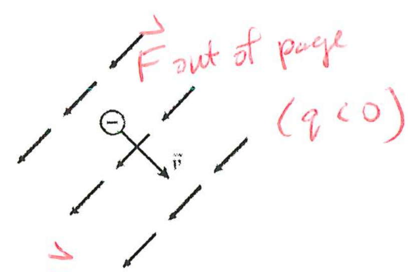
If I reduced by factor of 3, need to increase N by factor 3

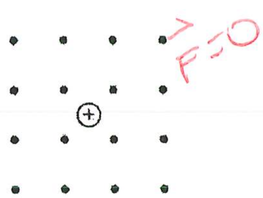
N goes from 1 layer to 3 layers.
→ 2 additional layers.

10. For each of the following, draw the magnetic force vector on the charge or, if appropriate, write "$\vec{F}$ into page," "$\vec{F}$ out of page," or "$\vec{F} = \vec{0}$."

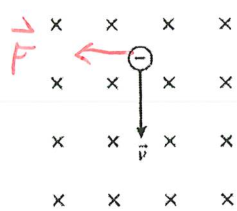
a.


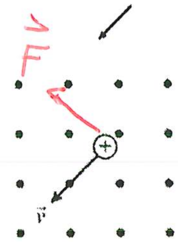

b.



c.



d.


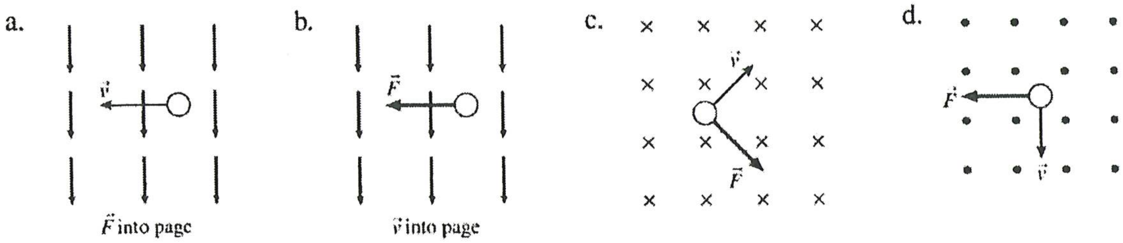

$\vec{v}$ out of page

e.



f.


11\.

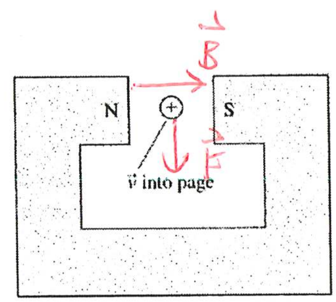
For each of the following, determine the sign of the charge (+ or −).




a. $q =$ −  b. $q =$ +  c. $q =$ −  d. $q =$ +

12\.

A positive ion, initially traveling into the page, is shot through the gap in a horseshoe magnet. Is the ion deflected up, down, left, or right? Explain.




$\vec{F} \propto \vec{V} \times \vec{B}$

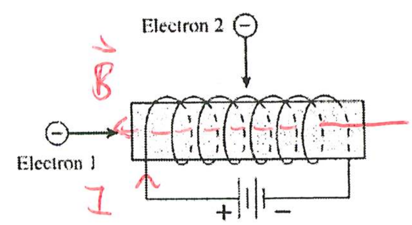
by RHR $\vec{F}$ is down

13\.

A hollow solenoid is wound as shown and attached to a battery. Two electrons are fired into the solenoid, one from the end and one through a very small hole in the side.

a. In what direction does the magnetic field inside the solenoid point? Show it on the figure.

b. Is electron 1 deflected as it moves through the solenoid? If so, in which direction? If not, why not?




(a) $\vec{B}$ pts to left.

(b) $\vec{V}_1$ antiparallel to $\vec{B}$ $\therefore$ $\vec{F} = 0$, no deflection.

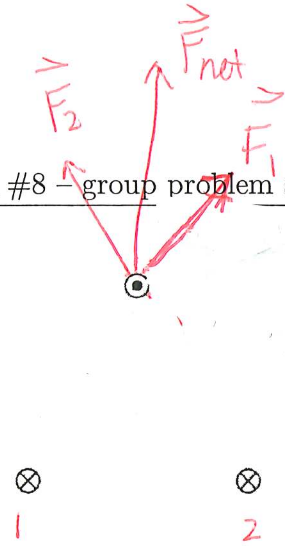
c. Is electron 2 deflected as it moves through the solenoid? If so, in which direction? If not, why not?

$\vec{F} = q\vec{V} \times \vec{B}$  $q < 0$

$\vec{F}$ is out of page.

14.

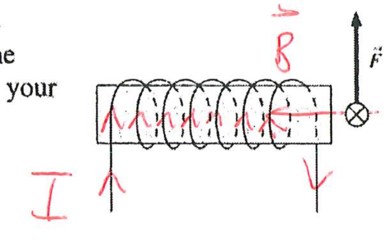
Three current-carrying wires are perpendicular to the page. Construct a force vector diagram on the figure to find the net force on the upper wire due to the two lower wires.




Parallel currents attract.
Anti-parallel currents repel.

15.

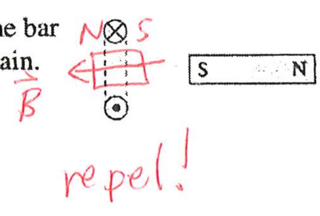
A current-carrying wire passes in front of a solenoid that is wound as shown. The wire experiences an upward force. Use arrows to show the direction in which the current enters and leaves the solenoid. Explain your choice.




$\vec{F} = I\vec{\ell} \times \vec{B}$

16.

The south pole of a bar magnet is brought toward the current loop. Does the bar magnet attract the loop, repel the loop, or have no effect on the loop? Explain.




repel!