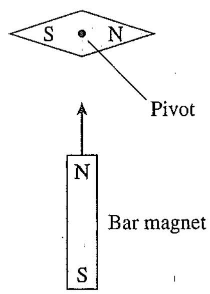
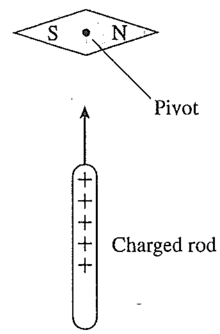
3. The compass needle below is free to rotate in the plane of the page. Either a bar magnet or a charged rod is brought toward the *center* of the compass. Does the compass rotate? If so, in which direction? If not, why not?

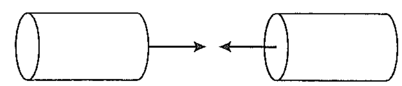
a.



b.



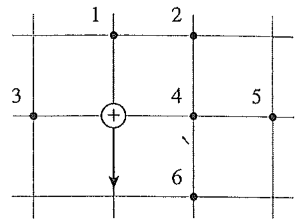
4. You have two electrically neutral metal cylinders that exert strong attractive forces on each other. You have no other metal objects. Can you determine if *both* of the cylinders are magnets, or if one is a magnet and the other just a piece of iron? If so, how? If not, why not?



5. Can you think of any kind of object that is repelled by *both* ends of a bar magnet? If so, what? If not, what prevents this from happening?

33.3 The Source of the Magnetic Field: Moving Charges

10. 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.

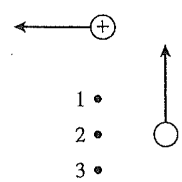


Order:

Explanation:

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

12. Two charges are moving as shown. At this instant of time, the net magnetic field at point 2 is $\vec{B}_2 = \vec{0}$.
    a. Is the unlabeled moving charge positive or negative? Explain.



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

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

33.4 The Magnetic Field of a Current

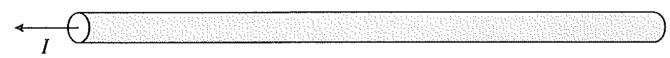
33.5 Magnetic Dipoles

13. Each figure shows a current-carrying wire. Draw the magnetic field diagram:

a.

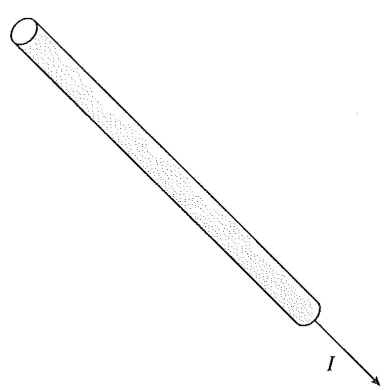
The wire is perpendicular to the page. Draw magnetic field *lines*, then show the magnetic field *vectors* at a few points around the wire.

b.

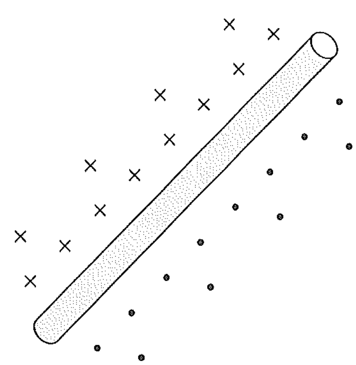


The wire is in the plane of the page. Show the magnetic field above and below the wire.

14. This current-carrying wire is in the plane of the page. Draw the magnetic field on both sides of the wire.

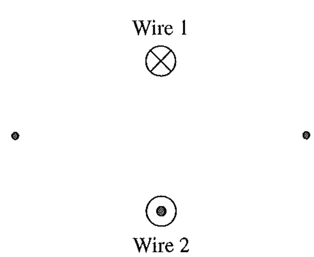


15. Use an arrow to show the current direction in this wire.

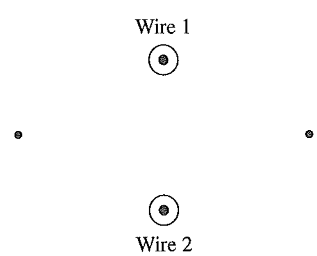


16. Each figure below shows two long straight wires carrying equal currents into and out of the page. At each of the dots, use a **black** pen or pencil to show and label the magnetic fields $\vec{B}_1$ and $\vec{B}_2$ of each wire. Then use a **red** pen or pencil to show the net magnetic field.

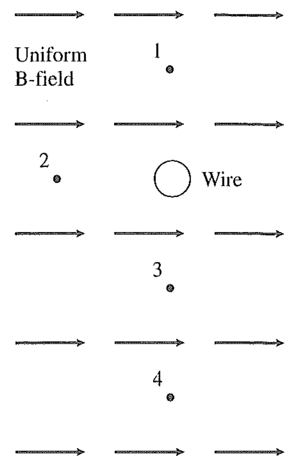
a.



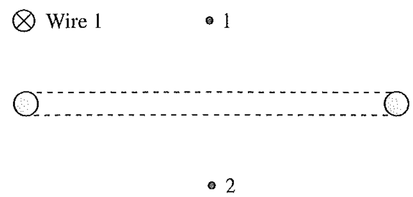
b.



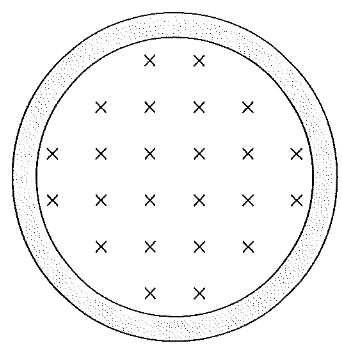
17. A long straight wire, perpendicular to the page, passes through a uniform magnetic field. The *net* magnetic field at point 3 is zero.
    a. On the figure, show the direction of the current in the wire.
    b. Points 1 and 2 are the same distance from the wire as point 3, and point 4 is twice as distant. Construct vector diagrams at points 1, 2, and 4 to determine the net magnetic field at each point.



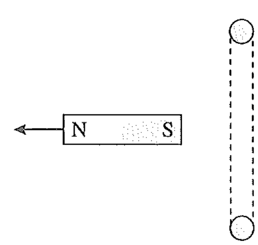
18. A long straight wire passes above one edge of a current loop. Both are perpendicular to the page. $\vec{B}_1 = \vec{0}$ at point 1.
    a. On the figure, show the direction of the current in the loop.
    b. Use a vector diagram to determine the net magnetic field at point 2.



19. The figure shows the magnetic field seen when facing a current loop in the plane of the page.
    a. On the figure, show the direction of the current in the loop.
    b. Is the north pole of this loop at the upper surface of the page or the lower surface of the page? Explain.

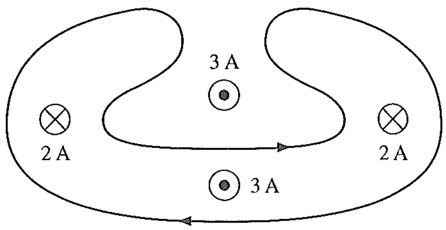


20. The current loop exerts a repulsive force on the bar magnet. On the figure, show the direction of the current in the loop. Explain.

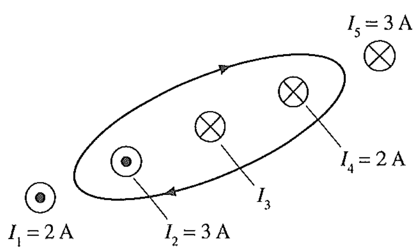


33.6 Ampère's Law and Solenoids

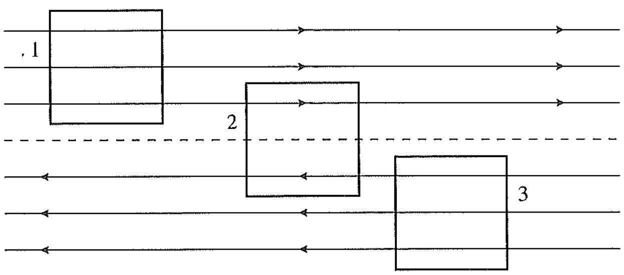
21. What is the total current through the area bounded by the closed curve?



22. The total current through the area bounded by the closed curve is 2 A. What are the size and direction of I_3?



23. 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 m × 1 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.

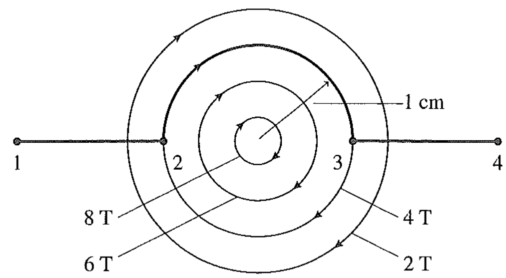


	Loop 1	Loop 2	Loop 3
$\int \vec{B} \cdot d\vec{s}$ along left edge			
$\int \vec{B} \cdot d\vec{s}$ along top			
$\int \vec{B} \cdot d\vec{s}$ along right edge			
$\int \vec{B} \cdot d\vec{s}$ along bottom			

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

$\oint \vec{B} \cdot d\vec{s}$ around the loop			

24. The strength of a circular magnetic field decreases with increasing radius as shown.



a. What is $\int_1^2 \vec{B} \cdot d\vec{s}$? ______

Explain or show your work.

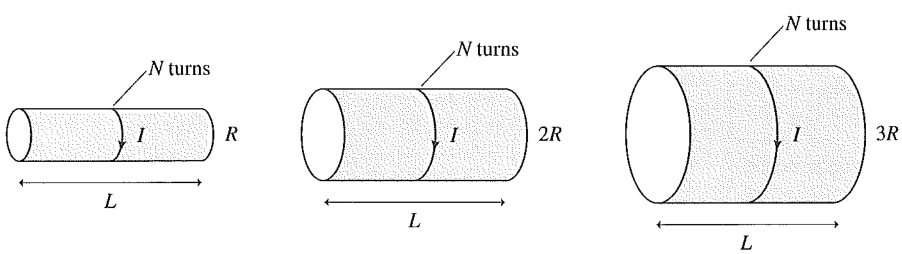
b. What is $\int_2^3 \vec{B} \cdot d\vec{s}$? ______ Explain or show your work.

c. What is $\int_3^4 \vec{B} \cdot d\vec{s}$? ______ Explain or show your work.

d. Combining your answers to parts a to c, what is $\int_1^4 \vec{B} \cdot d\vec{s}$? ______

25. 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.

26. Rank in order, from largest to smallest, the magnetic fields B_1 to B_3 produced by these three solenoids.



Order:

Explanation: