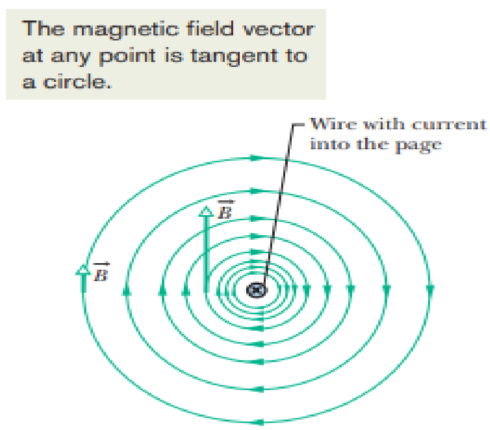
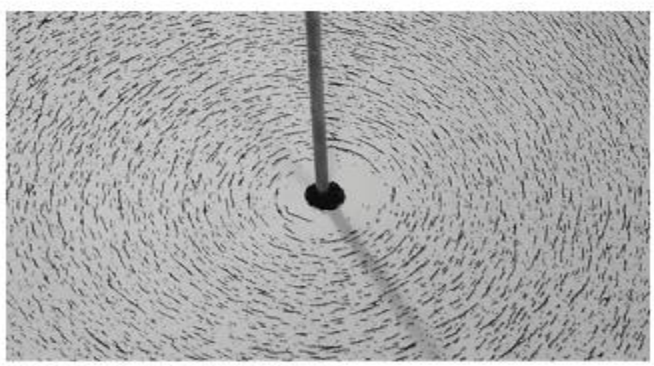
Ampere’s Law

Magnetic Field due to a Current Carrying Wirte

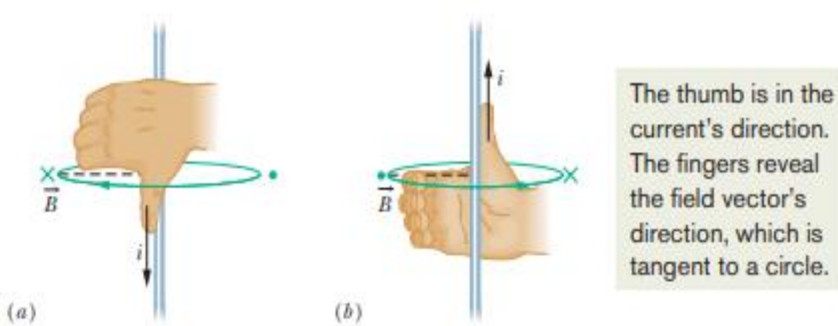


$$B = \frac{\mu_0 i}{2\pi r}$$



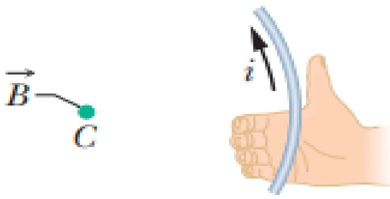
Courtesy Education Development Center

Figure 29-3 Iron filings that have been sprinkled onto cardboard collect in concentric circles when current is sent through the central wire. The alignment, which is along magnetic field lines, is caused by the magnetic field produced by the current.



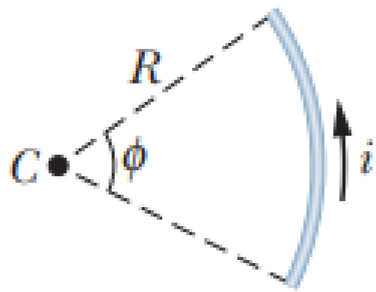
(1) A surveyor is using a magnetic compass 6.1 m below a power line in which there is a steady current of 100 A. (a) What is the magnetic field at the site of the compass due to the power line? (b) Will this field interfere seriously with the compass reading? The horizontal component of Earth's magnetic field at the site is 20 mT.

Magnetic Field Due to a Current in a Circular Arc of Wire



(c)

The right-hand rule reveals the field's direction at the center.

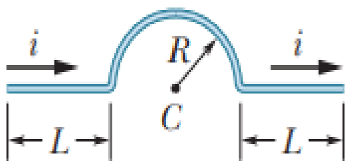


$$B = \frac{\mu_0 i \phi}{4\pi R} \quad \text{(at center of circular arc).}$$

To find the magnitude of the magnetic field at the center of a full circle of current, you would substitute 2π rad for Φ.

$$B = \frac{\mu_0 i(2\pi)}{4\pi R} = \frac{\mu_0 i}{2R} \quad \text{(at center of full circle).}$$

(2) In Fig. a wire forms a semicircle of radius R = 9.26 cm and two (radial) straight segments each of length L = 13.1 cm. The wire carries current i = 34.8 mA. What are the (a) magnitude and (b) direction (into or out of the page) of the net magnetic field at the semicircle's center of curvature C?



Force Between Two Parallel Currents

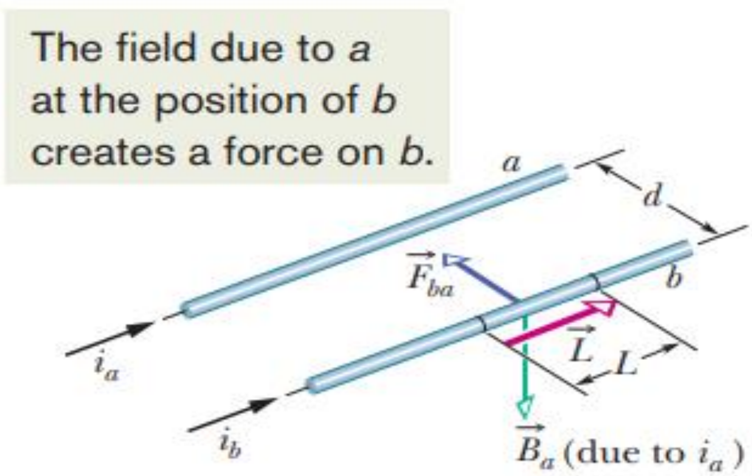


Figure 29-10 Two parallel wires carrying currents in the same direction attract each other. $\vec{B}_a$ is the magnetic field at wire b produced by the current in wire a. $\vec{F}_{ba}$ is the resulting force acting on wire b because it carries current in $\vec{B}_a$.

Force on a length L of wire b due to the external magnetic field is

$$\vec{F}_{ba} = i_b \vec{L} \times \vec{B}_a,$$

Similarly, $F_{ab} = i_a \ L \times B_b$

Important

So, the two conducting wires will attract each other and if we reverse the direction of the current they will repel each other.

Magnetic Field inside a Solenoid

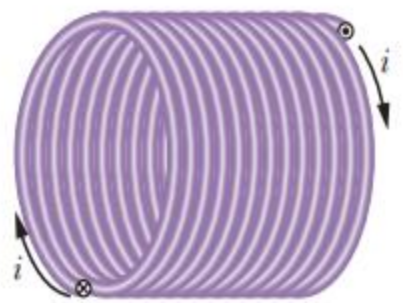
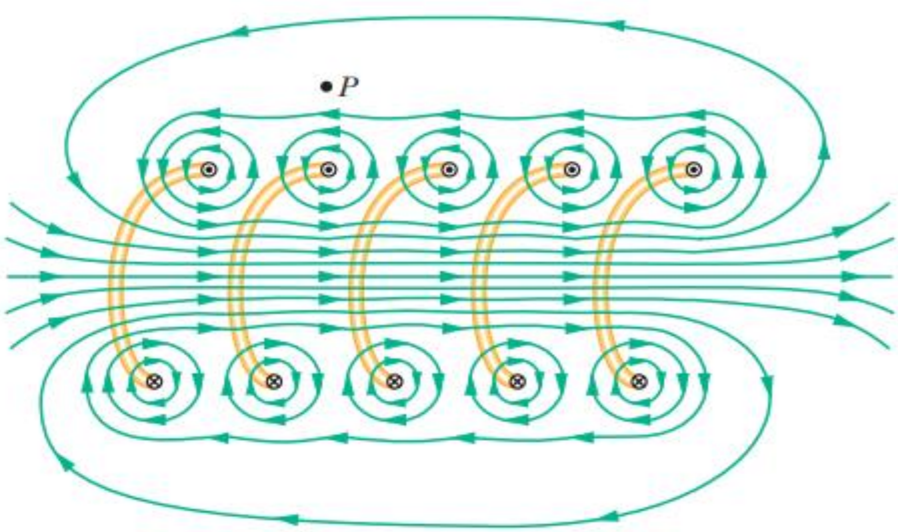


Figure 29-17 A solenoid carrying current i.



$$B = \mu_0 i n \qquad \text{(ideal solenoid).}$$

Magnetic Field inside a Toroid

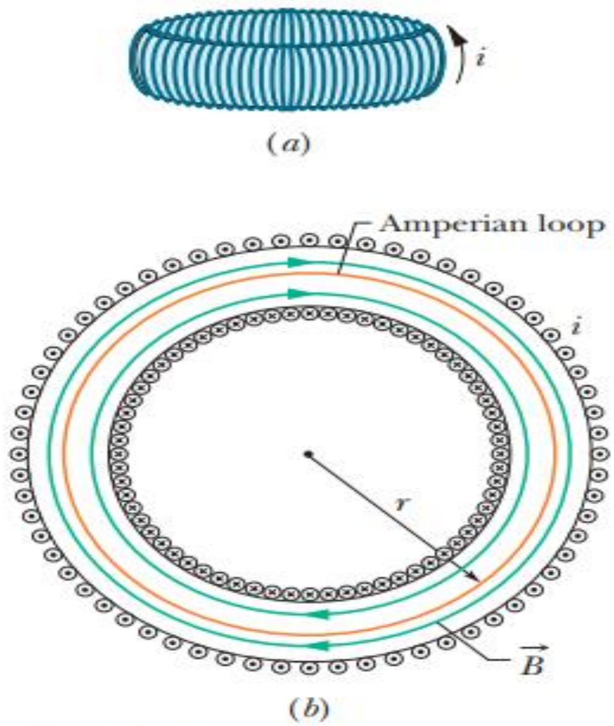


Figure 29-21 (*a*) A toroid carrying a current *i*. (*b*) A horizontal cross section of the toroid. The interior magnetic field (inside the bracelet-shaped tube) can be found by applying Ampere's law with the Amperian

$$B = \frac{\mu_0 i N}{2\pi}\frac{1}{r} \quad \text{(toroid).}$$

(3) A solenoid that is 95.0 cm long has a radius of 2.00 cm and a winding of 1200 turns; it carries a current of 3.60 A. Calculate the magnitude of the magnetic field inside the solenoid. •

$$B = \mu_0 i n = \mu_0 i\left(\frac{N}{\ell}\right)$$

where $i = 3.60$ A, $\ell = 0.950$ m, and $N = 1200$. This yields $B = 0.00571$ T.