otherwise we would have to use integral calculus) is as follows:

$$B\,(2\pi r) = \mu_o I$$

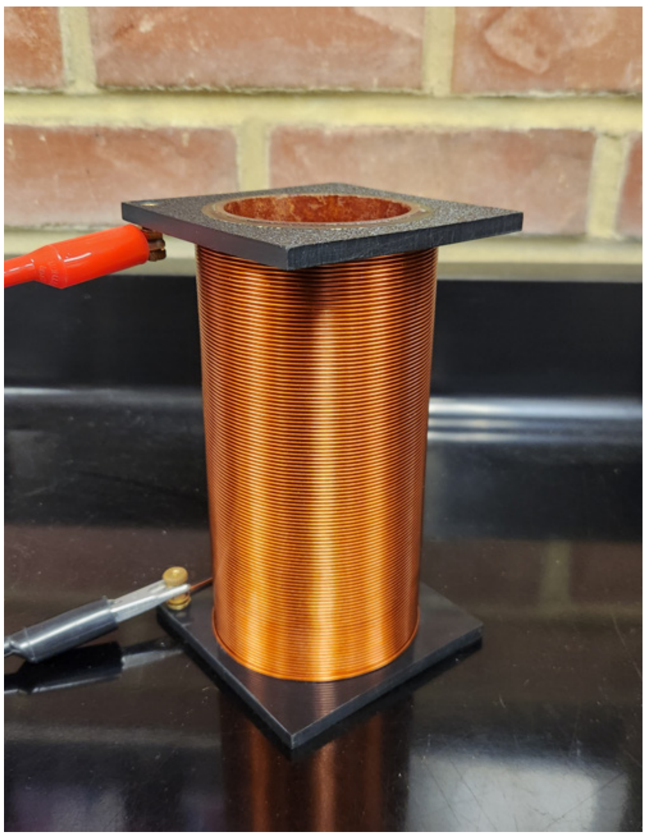
In this expression, I is specifically the current passing through our Amperian loop. B is the magnetic field, and $2\pi r$ is the length around our Amperian loop (the circumference of a circle with radius r). Solving for B, we get:

$$B = \frac{\mu_o I}{2\pi r}$$

This tells us that the magnetic field from a long straight wire varies inversely with distance r. Also, as with Gauss's law, we have a new constant: μ_o. This constant is known as the **permeability of free space**. What this constant means is not important now—it is just a constant that is the same in every calculation.

Although many devices simply use long straight wires, another common orientation is to form multiple circular loops on top of each other, which is known as a **solenoid** (Figure 74). What is the magnetic field of a solenoid?

FIGURE 74



A wire bent into multiple loops on top of each other is a solenoid, which can be used for various purposes in electric circuits.

Imagine a wire with current coming straight at you, out of the page. From our right-hand rule, we know that the magnetic field will curl around it counterclockwise, or go up on the right side and down on the left side. Now, take the wire and curl it around, so the other half is going into the page to the right of it. The magnetic field on that side of the wire will go clockwise, or up to the left of it and down to the right of it. If we loop the wire back on itself, you can see that on the outside of the loop, the magnetic field is going down. And, inside the loop the magnetic field is going up. If instead of connecting the two ends of the wire, we keep making more loops on top of it, forming a coil, this reinforces the effect. The magnetic field of a solenoid looks just like the magnetic field of a bar magnet (Figure 75).