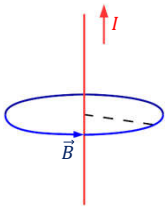
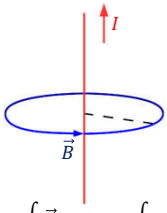
Magnetic Field of a Long Straight Wire



$\vec{B}$ is constant at a given distance from the wire with a value, $B = \frac{\mu_0 I}{2\pi r}$.

Magnetic Field of a Long Straight Wire

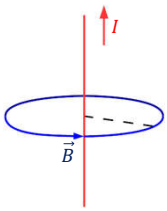


$\vec{B}$ is constant at a given distance from the wire with a value, $B = \frac{\mu_0 I}{2\pi r}$.

Consider the line integral around the closed circular path shown.

$$\oint \vec{B} \cdot d\vec{s} = B \oint ds = B(2\pi r) = \left(\frac{\mu_0 I}{2\pi r}\right)(2\pi r) = \mu_0 I$$

Ampere's Law

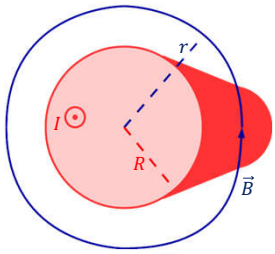


$$\oint \vec{B} \cdot d\vec{s} = \mu_0 I_{\text{enclosed}}$$

True in general, not just for long straight wires. Useful IF symmetry allows us to factor B out of the integral.

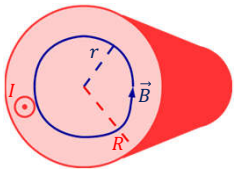
Three Applications of Ampere's Law
First, Long Straight Wire

Outside:

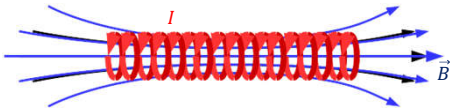


Three Applications of Ampere's Law
First, Long Straight Wire

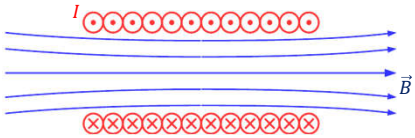
Inside:



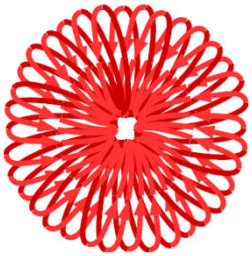
Three Applications of Ampere's Law
Second, Solenoid



Three Applications of Ampere's Law
Second, Solenoid



Three Applications of Ampere's Law
Third, Toroidal Solenoid



Three Applications of Ampere's Law
Third, Toroidal Solenoid