# Magnetic Fields, Special Cases

**Physics 106**

## Concepts:
1. Magnetic field of a long, straight wire
2. Magnetic Force between Two Parallel Conductors
3. Magnetic Field of a Current Loop
4. Magnetic Field of a Solenoid

## Units

<table>
<thead>
<tr>
<th>Magnetic Field, Tesla (T),</th>
<th>$[B] = \frac{Wb}{m^2} = \frac{N}{C \cdot m/s} = \frac{N}{A \cdot m}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu_0 = 4\pi \times 10^{-7} T \cdot m/A$</td>
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</table>

## Equations:

**Long straight wire:** \( B = \frac{\mu_0 I}{2\pi r} \), where \( \mu_0 \) is a constant, \( I \) is current and \( r \) is the radius.

\( \mu_0 = 4\pi \times 10^{-7} T \cdot m/A \)

**For two parallel conductors:** \( \frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi d} \),

where \( l \) is the length of the conductors and \( d \) is the distance apart.

**Solenoid:** \( B = \mu_0 nI \), where \( n \) is the number of coils

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**Sample Problem**

One conductor carries a current of 10 Amps. Point \( A \) is the midpoint between the wires, and point \( C \) is 5 cm to the right of the 10 Amp current. \( I \) is adjusted so that the magnetic field at \( C \) is zero. Find the value of the current \( I \) and the value of the magnetic field at \( A \).
### Sample Problem

Find the magnetic field at point P.

![Diagram](https://via.placeholder.com/156x601.png)

### Physics Hero

Find the magnetic field at point P.

![Diagram](https://via.placeholder.com/156x396.png)

### Sample Exam Question

An incredible amount of electrical energy passes down the funnel of a large tornado every second. Measurements taken in Oklahoma at a distance of 9.00 km from a large tornado showed an almost constant magnetic field of \(1.50 \times 10^{-8} \text{T}\) associated with the tornado. What was the average current going down the funnel?

- a. 450 A
- b. 675 A
- c. 950 A
- d. 1 500 A

### Sample Conceptual Exam Question

Consider two long, straight parallel wires, each carrying a current \(I\). If the currents are flowing in opposite directions:

- a. the two wires will attract each other.
- b. the two wires will repel each other.
- c. the two wires will exert a torque on each other.
- d. neither wire will exert a force on the other