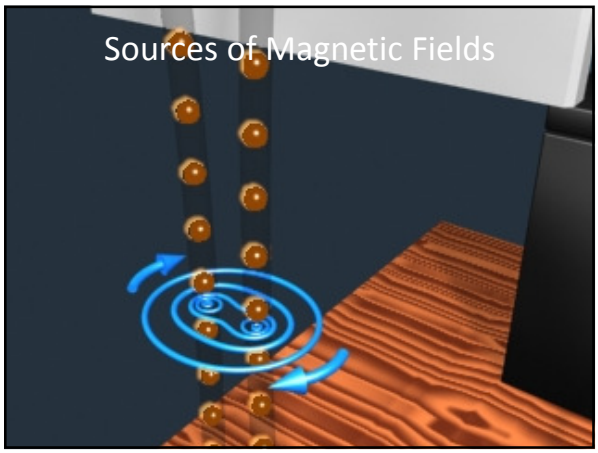
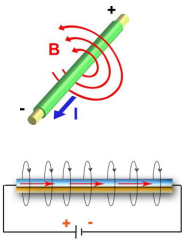



## Moving charges create magnetic fields

- The magnetic field acts on moving charges only) and is created by moving charges only!
- The magnitude of the magnetic field of a long straight wire is:

$$\boxed{|\vec{B}_{wire}| = \frac{\mu_0 I}{2\pi r}}$$

- $\mu_0 = 4\pi \times 10^{-7}\text{Tm/A}$ called permeability of free space







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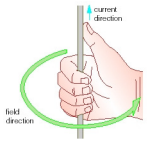
## Direction of Magnetic Field of a Wire

http://youtu.be/eK1Ar5WPJj8




The direction of the magnetic field of a long straight wire is given by Right-Hand Rule #2 (the one we used to find the direction of $\vec{m}$)

3

## Quickuiz

4

## Magnetic field of circular coil of wire

- Seeing field as the sum of little bits of straight wire
- Magnitude of the magnetic field in the center of a coil of wire:

$$\left|\vec{B}_{coil}\right| = \frac{\mu_0 NI}{2r}$$

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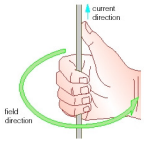
## Direction of Field at Center of Coil

- How does the field around a coil look like?
- Use the right-hand-rule to find it.




6

## Quickuiz

7

## The solenoid: creating a uniform field

- A solenoid is a long wire wound around some axis.
- What's the difference between a solenoid and a coil?

- Magnetic field magnitude throughout interior of solenoid:

$$|\vec{B}_{sol}| = \frac{\mu_0 NI}{L}$$

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## Direction of Field

- What's the direction of field inside the solenoid?

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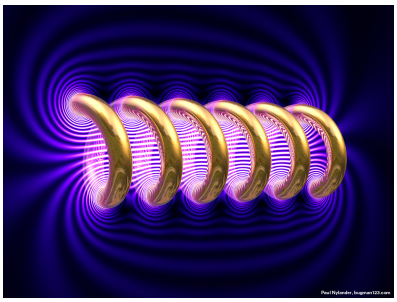
## Realistic Solenoid



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## Demo Problem

- A circular coil of wire with the $x$-axis as its axis of symmetry, and the origin as its center, contains 10 loops of wire and has a radius $r_{coil}0.100$ m. The coil carries a current $I_{coil} = 10.0$ A. Sharing the same axis of symmetry as the coil is a long solenoid with radius $r_{sol} = 0.150$ m, length $L_{sol} = 0.800$ m and $N_{sol} = 1200$ loops of wire. A current $I_{sol} = 0.500$ A flows in the solenoid's wires.
- Create a diagram visualizing the situation.

$$|\vec{B}_{wire}| = \frac{\mu_0 I}{2\pi r}$$
$$|\vec{B}_{coil}| = \frac{\mu_0 NI}{2r}$$
$$|\vec{B}_{sol}| = \frac{\mu_0 NI}{L}$$
$$\mu_0 = 4\pi \times 10^{-7}\text{Tm/A}$$

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## Demo Problem

- A circular coil of wire with the $x$-axis as its axis of symmetry, and the origin as its center, contains 10 loops of wire and has a radius $r_{coil}0.100$ m. The coil carries a current $I_{coil} = 10.0$ A. Sharing the same axis of symmetry as the coil is a long solenoid with radius $r_{sol} = 0.150$ m, length $L_{sol} = 0.800$ m and $N_{sol} = 1200$ loops of wire. A current $I_{sol} = 0.500$ A flows in the solenoid's wires.
- Find the magnitude of the magnetic fild produced by the coil at the origin, and the magnitude of the magnetic field produced by the solenoid at the origin.

$$|\vec{B}_{wire}| = \frac{\mu_0 I}{2\pi r}$$
$$|\vec{B}_{coil}| = \frac{\mu_0 NI}{2r}$$
$$|\vec{B}_{sol}| = \frac{\mu_0 NI}{L}$$
$$\mu_0 = 4\pi \times 10^{-7}\text{Tm/A}$$

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## Demo Problem

- A circular coil of wire with the $x$-axis as its axis of symmetry, and the origin as its center, contains 10 loops of wire and has a radius $r_{coil} 0.100\ \mathrm{m}$. The coil carries a current $I_{coil} = 10.0\ \mathrm{A}$. Sharing the same axis of symmetry as the coil is a long solenoid with radius $r_{sol} = 0.150\ \mathrm{m}$, length $L_{sol} = 0.800\ \mathrm{m}$ and $N_{sol} = 1200$ loops of wire. A current $I_{sol} = 0.500\ \mathrm{A}$ flows in the solenoid's wires.
- If both the coil's current and the solenoid's current flow clockwise as viewed a vantage point at positive-$x$, what is the total magnetic field at the origin? Specify the magnetic field as $(B_x, B_y, B_z)$, i.e. by giving the three components of the magnetic field.

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## Demo Problem

- A circular coil of wire with the $x$-axis as its axis of symmetry, and the origin as its center, contains 10 loops of wire and has a radius $r_{coil} 0.100\ \mathrm{m}$. The coil carries a current $I_{coil} = 10.0\ \mathrm{A}$. Sharing the same axis of symmetry as the coil is a long solenoid with radius $r_{sol} = 0.150\ \mathrm{m}$, length $L_{sol} = 0.800\ \mathrm{m}$ and $N_{sol} = 1200$ loops of wire. A current $I_{sol} = 0.500\ \mathrm{A}$ flows in the solenoid's wires.
- If instead the solenoid's current flows counterclockwise as viewed from the vantage point at positive-x, what is the total magnetic field at the origin? Specify as $(B_x, B_y, B_z)$.

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