PHYS102
Effects
of
Magnetic Fields

Dr. Suess

March 12, 2007

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  - See a resemblance to the electric field generated by point particles?

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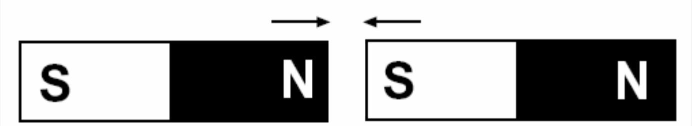

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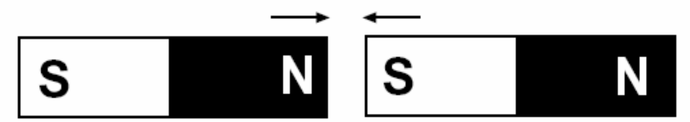

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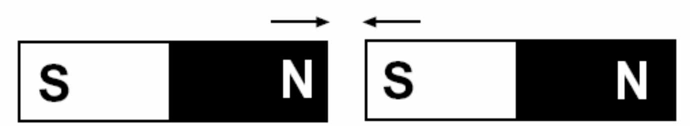

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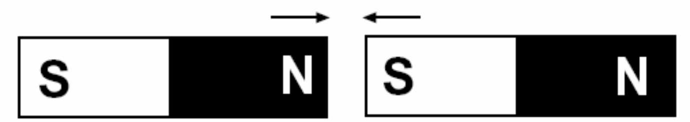

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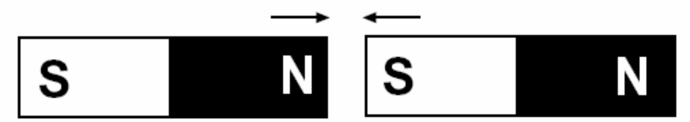

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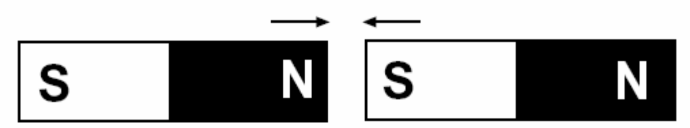

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- We can calculate the force a charged particle experiences whilst in a magnetic field.

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  - A magnetic field (bar magnet) is placed near this beam.

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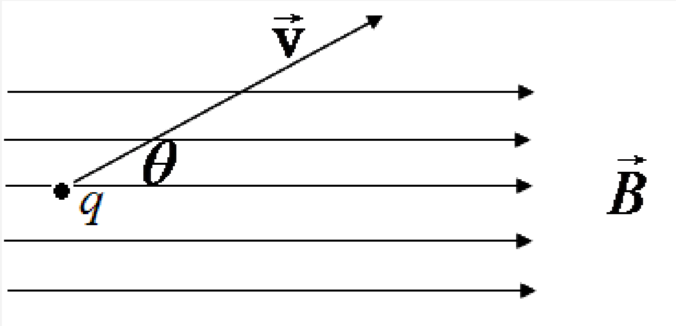

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  - We need to define a notation that is consistent.

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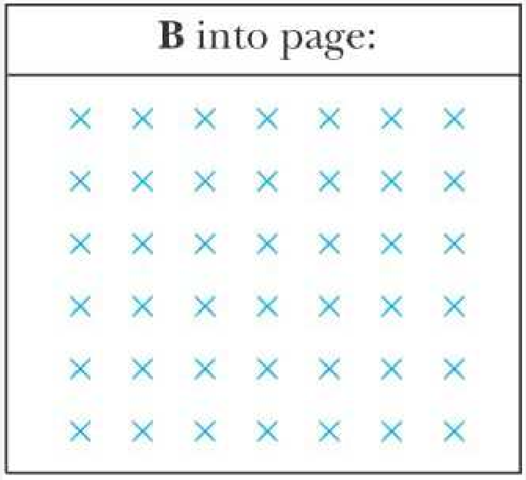

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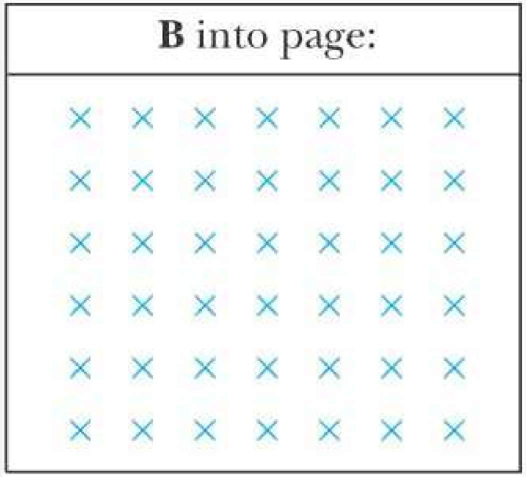

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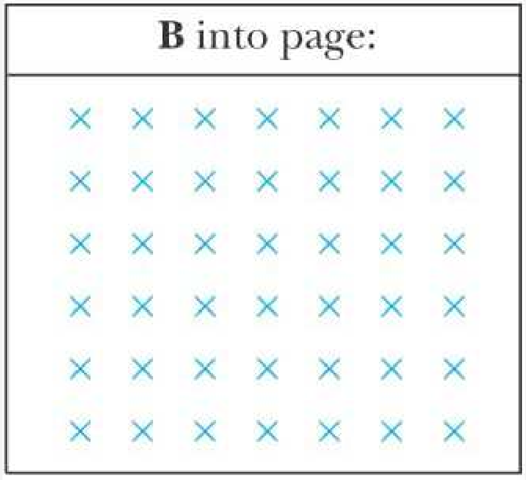

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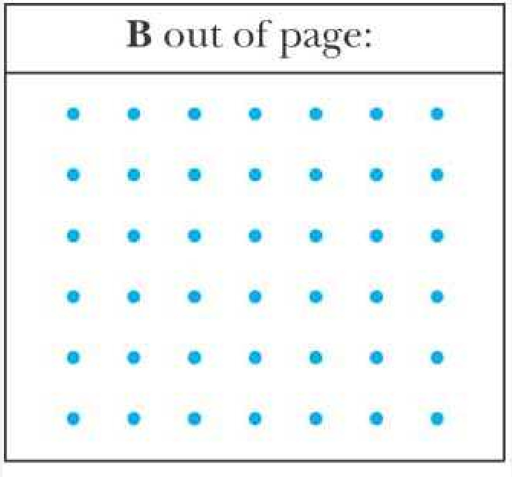
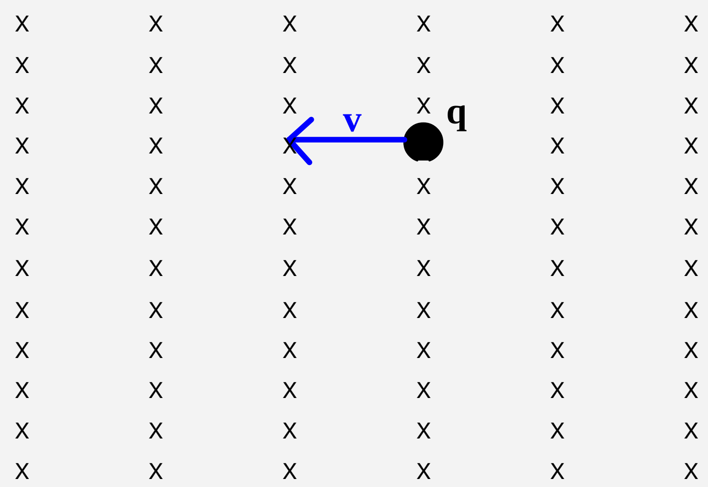


Charged Particle Motion in B-Field



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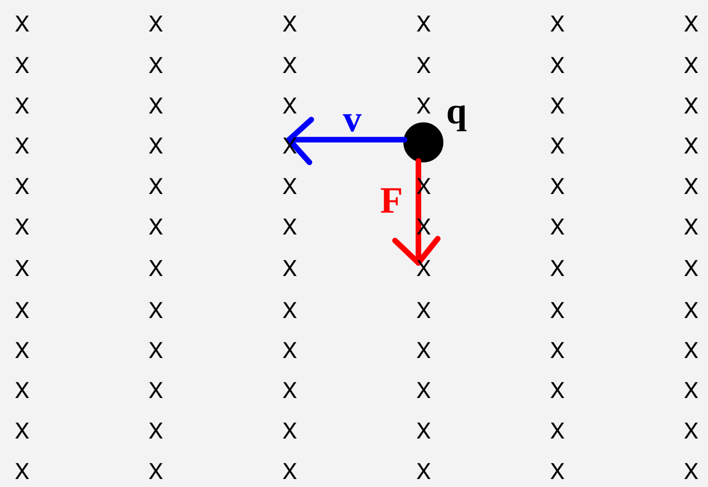

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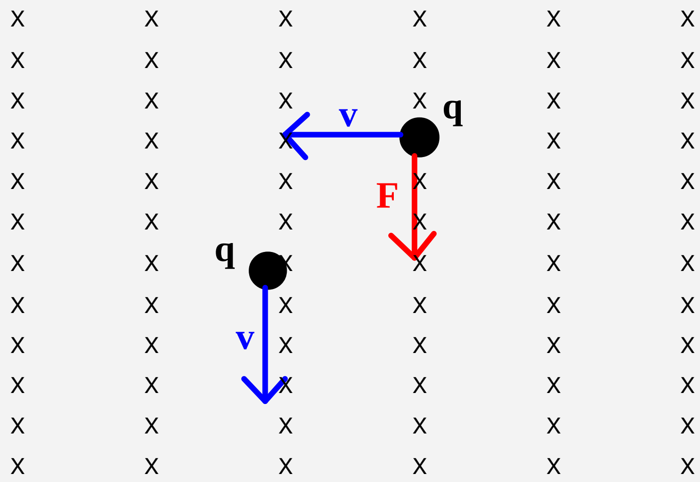

- A positive charged particle entering a uniform magnetic field experiences a force perpendicular to its displacement.

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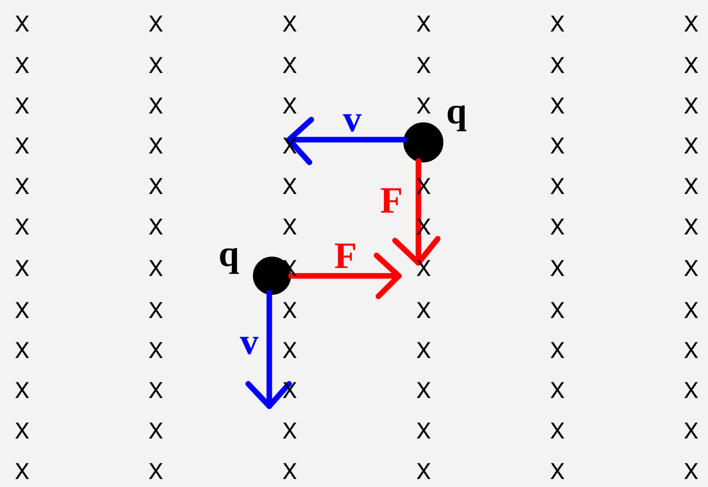

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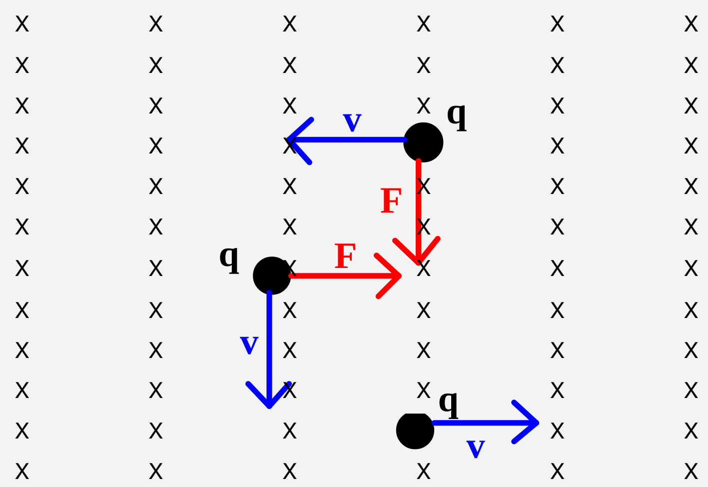

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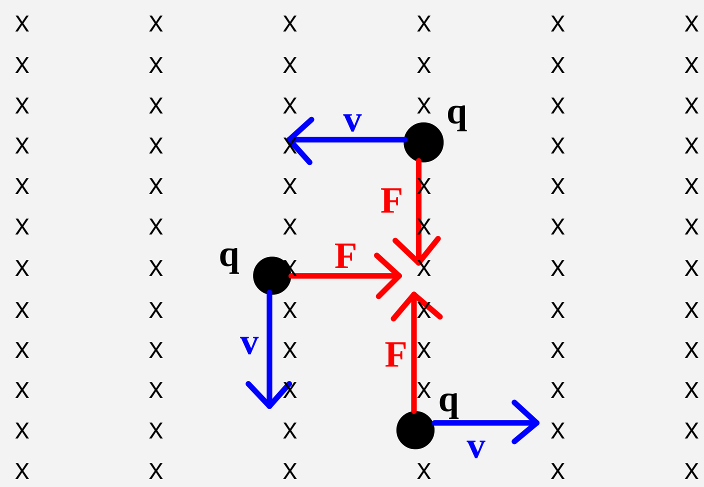

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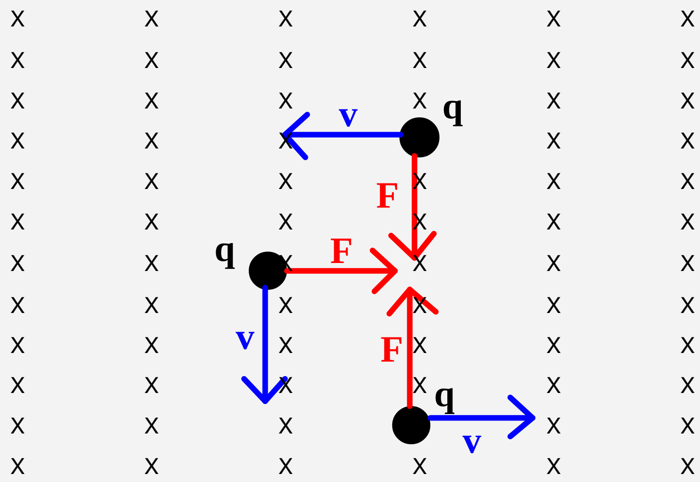

- We could calculate the radius of curvature,

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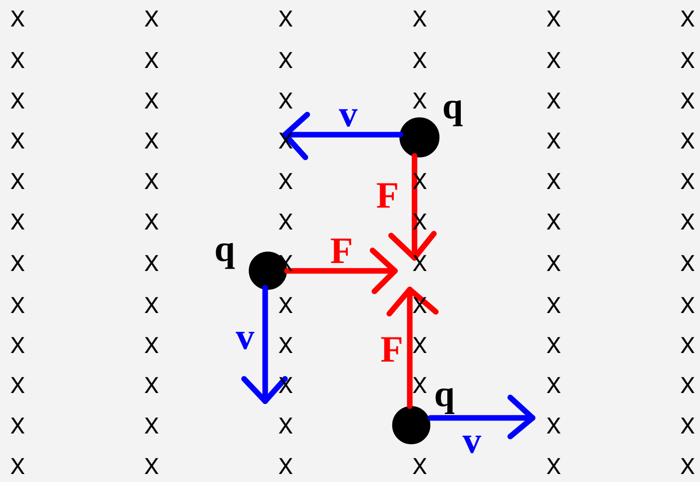

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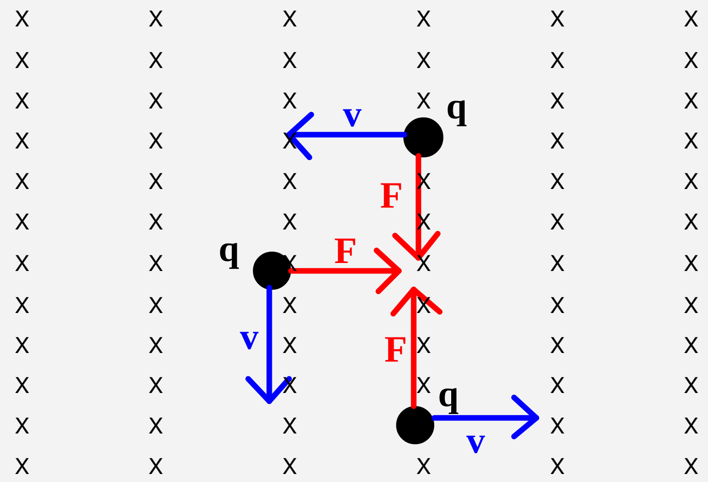

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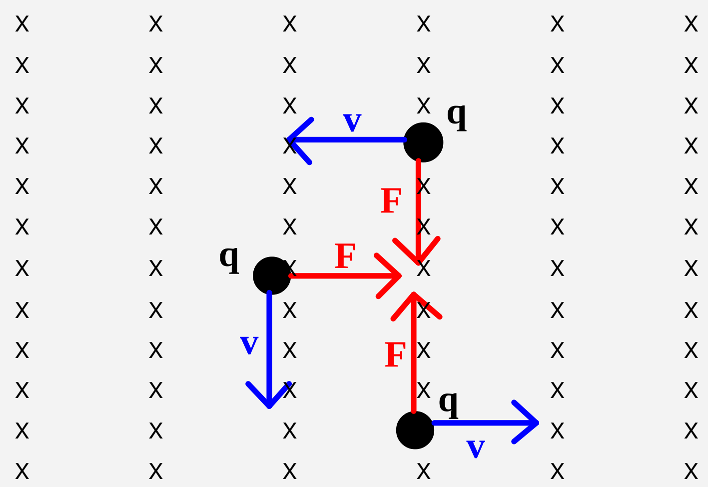

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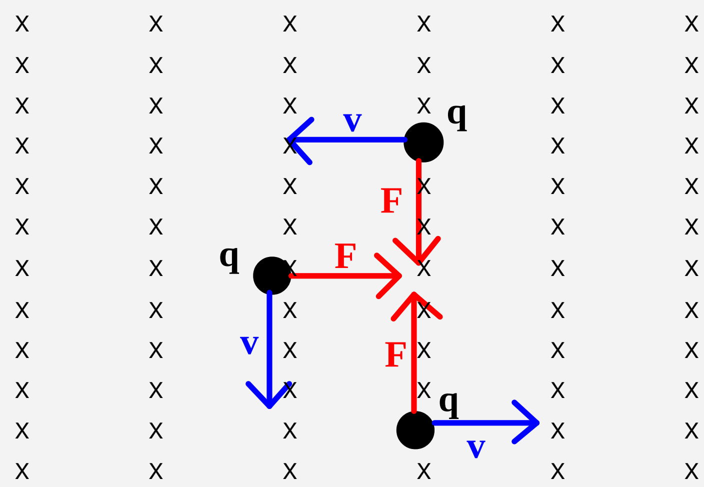

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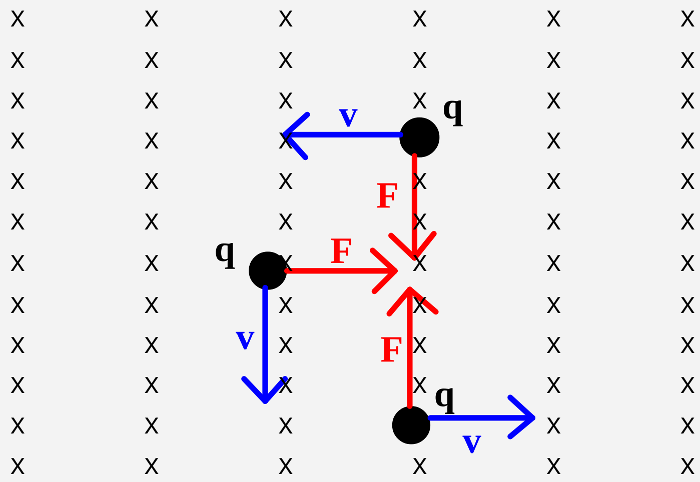

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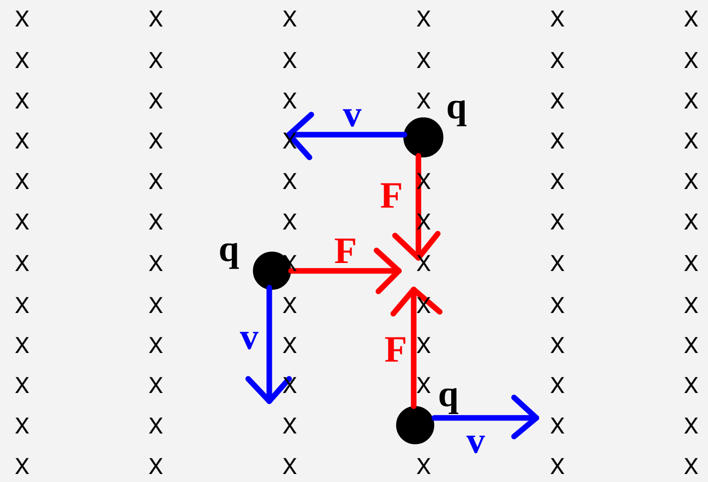
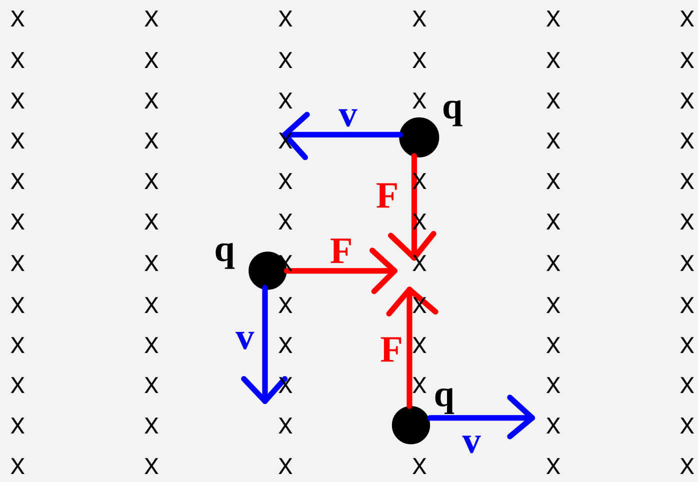
$$\Rightarrow r = \frac{m\,v}{q\,B}$$

Charged Particle Motion in B-Field II



- We could also calculate the time it takes the particle to complete one revolution.

Charged Particle Motion in B-Field II



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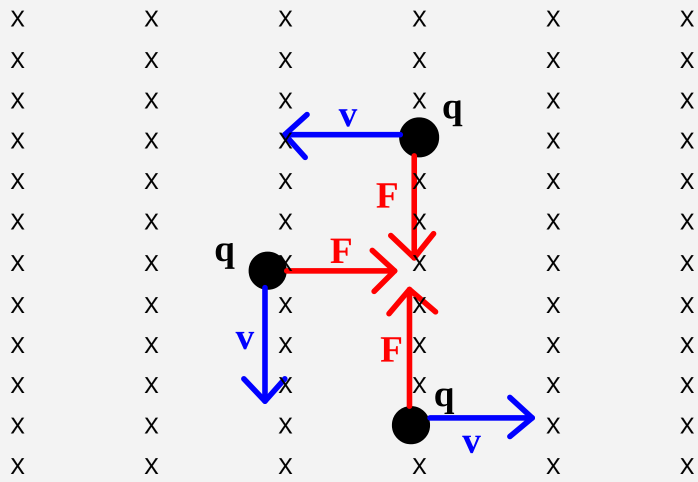

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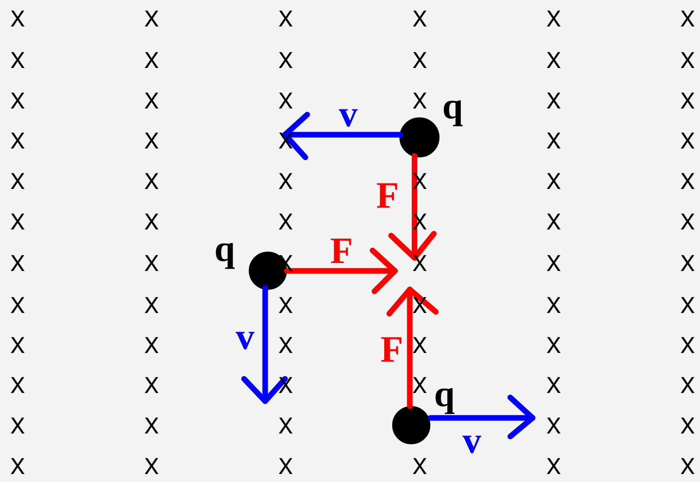

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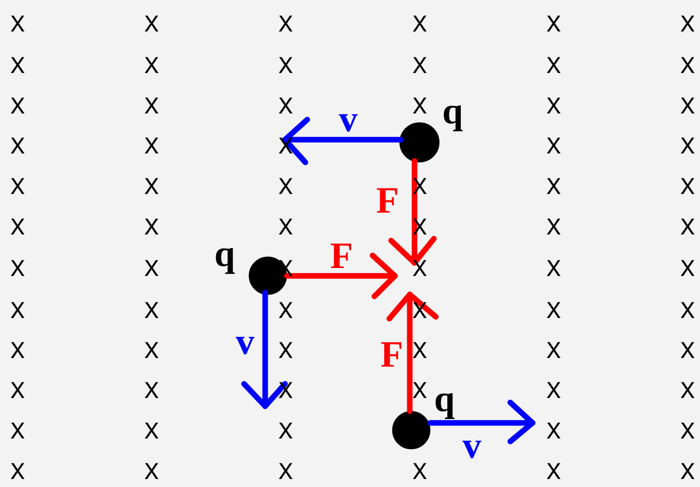

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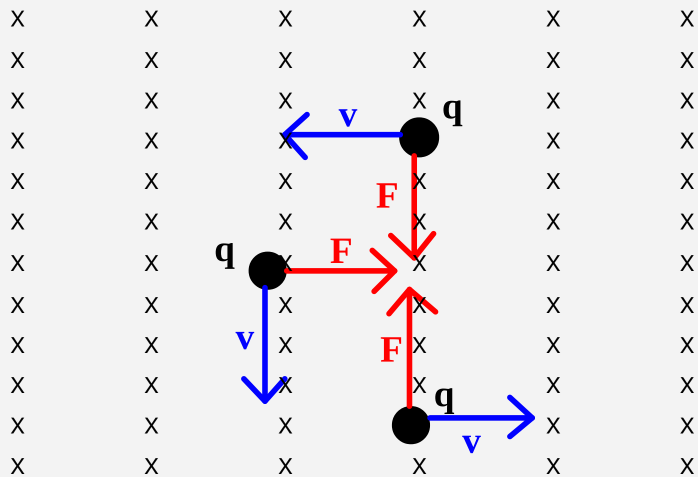

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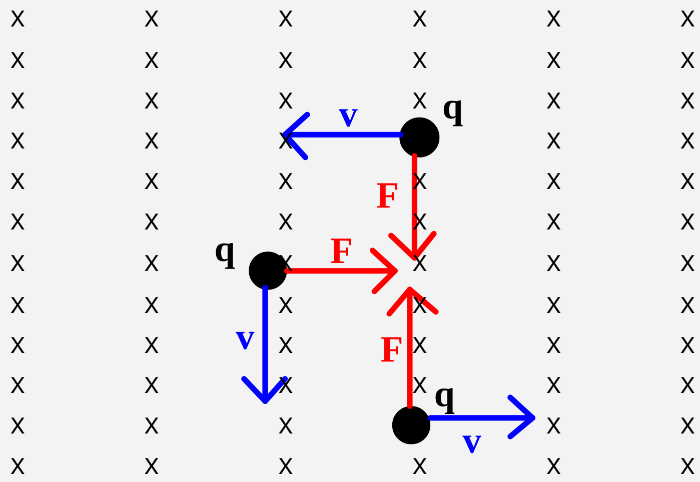

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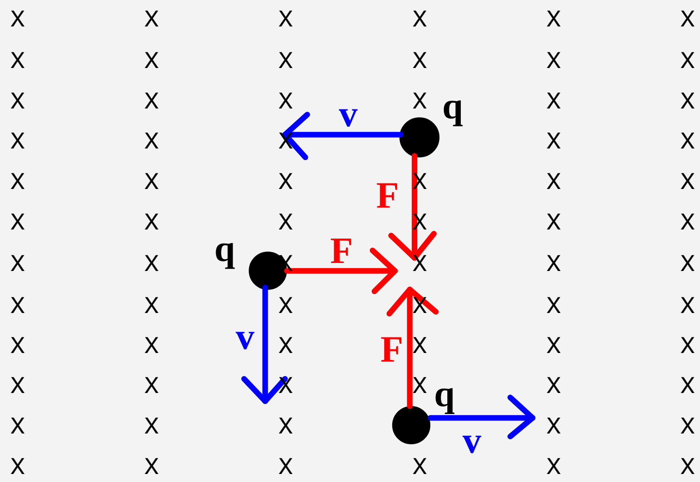

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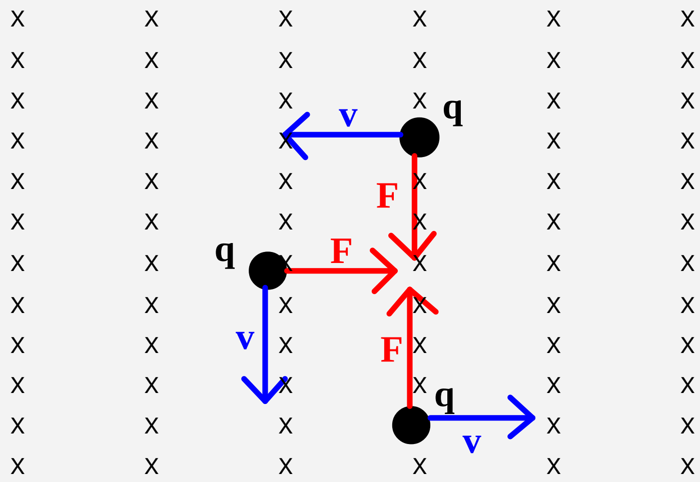

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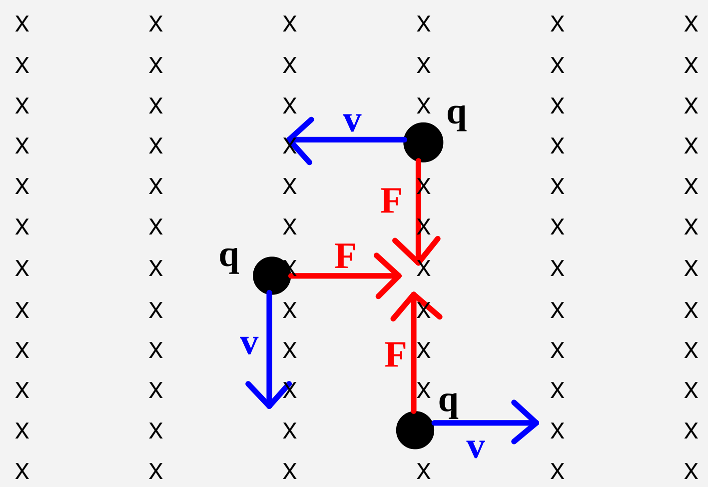

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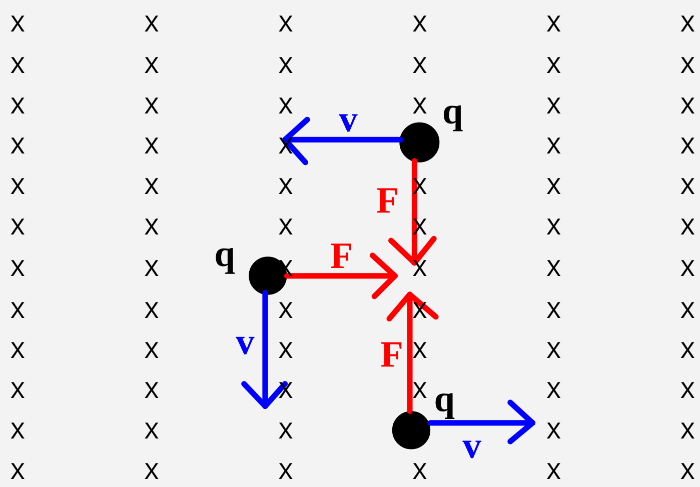

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$$\omega = 2\,\pi\,f$$

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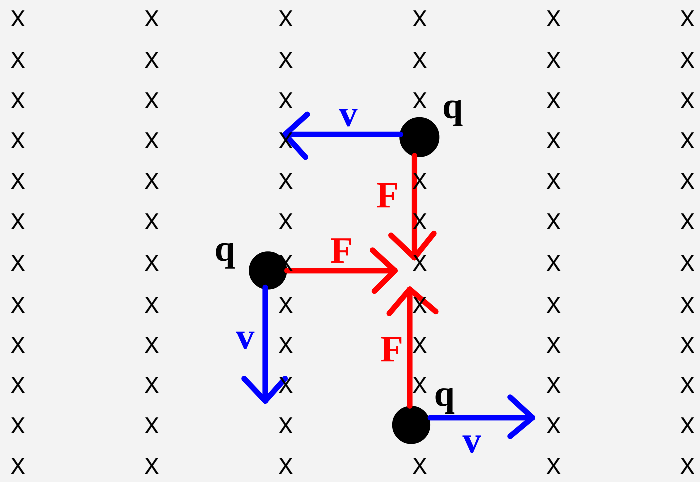

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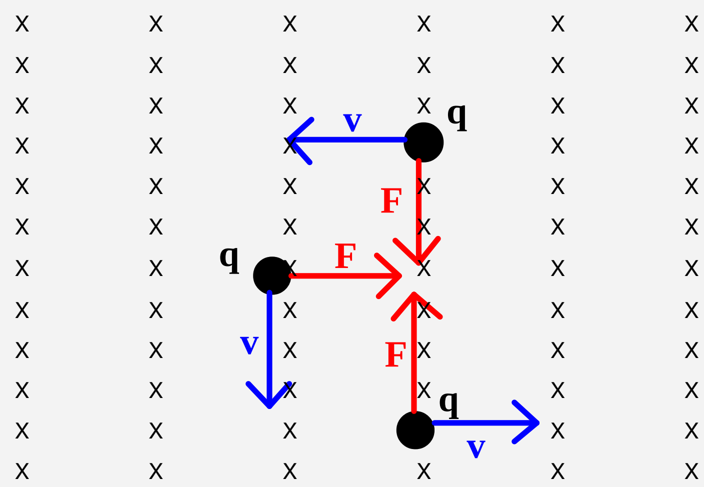

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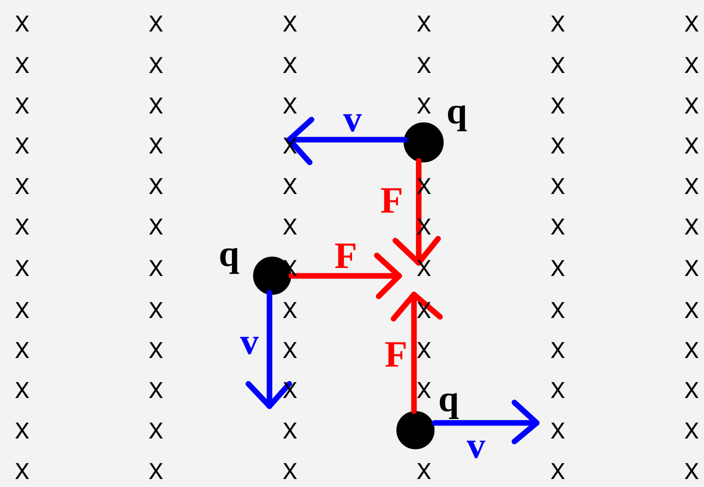

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Force on Wires Carrying Current

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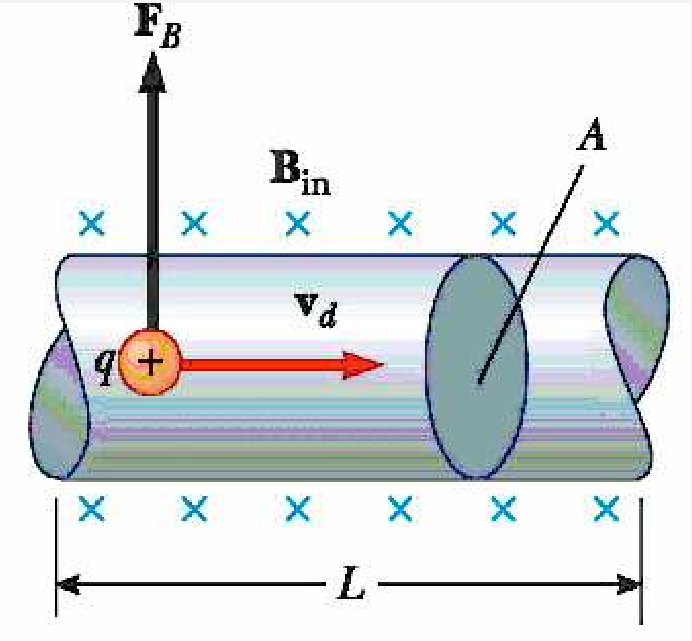
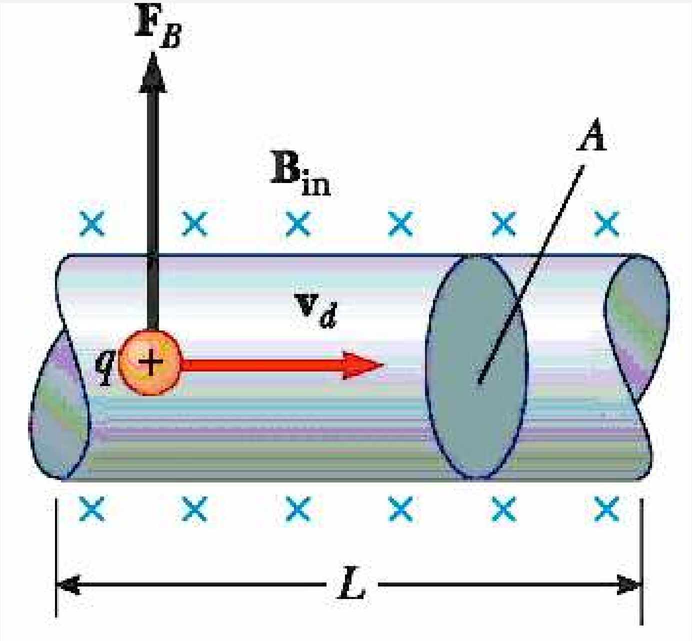
- We don't have a single charged particle instead we have a current (I).

Force on Wires Carrying Current II



- The magnetic force is experienced by each moving charge in the current.

Force on Wires Carrying Current II



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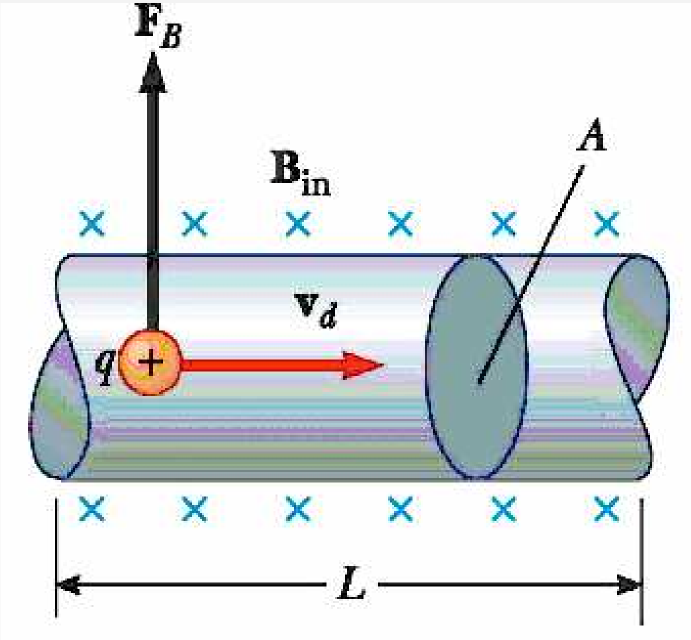

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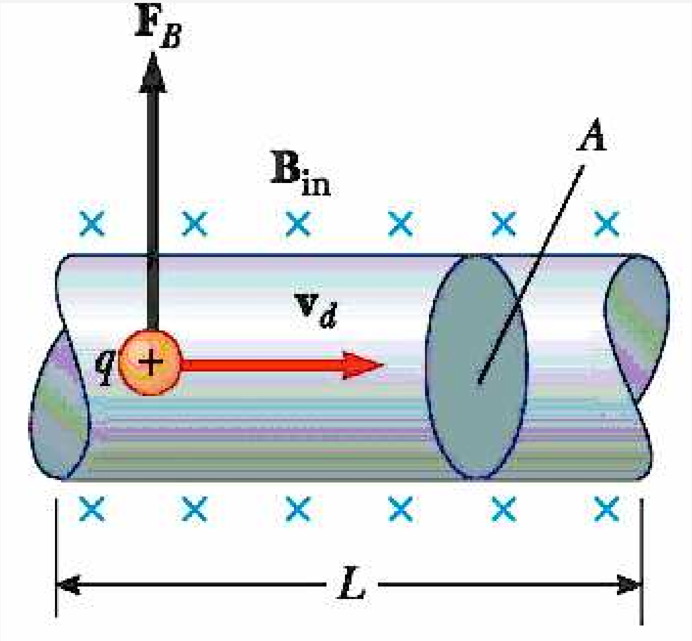
$$\vec{F}_B = (q\,\vec{v} \times \vec{B})\,n\,A\,L = I\,\vec{L} \times \vec{B}$$

Force on Wires Carrying Current III



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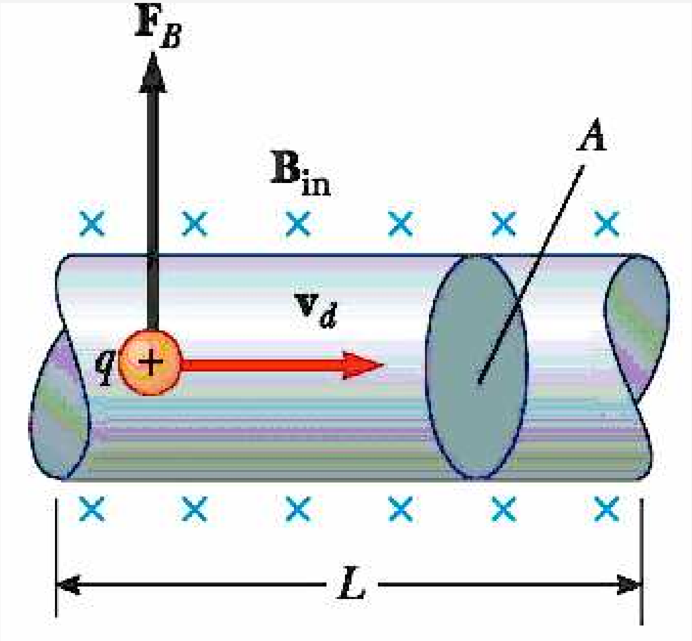
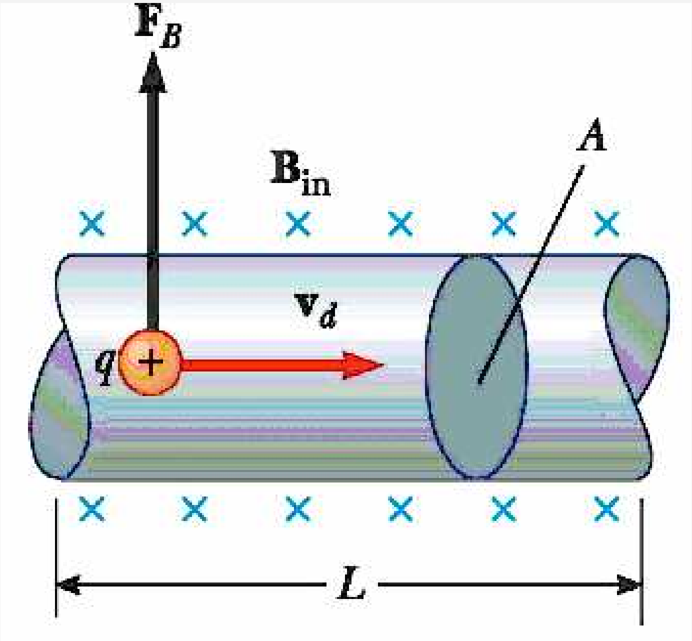


$$\vec{F}_B = I\,\vec{L}\,\times\,\vec{B}$$

- The vector $\vec{L}$ has magnitude L and is in the direction of current .

Force on Wires Carrying Current III



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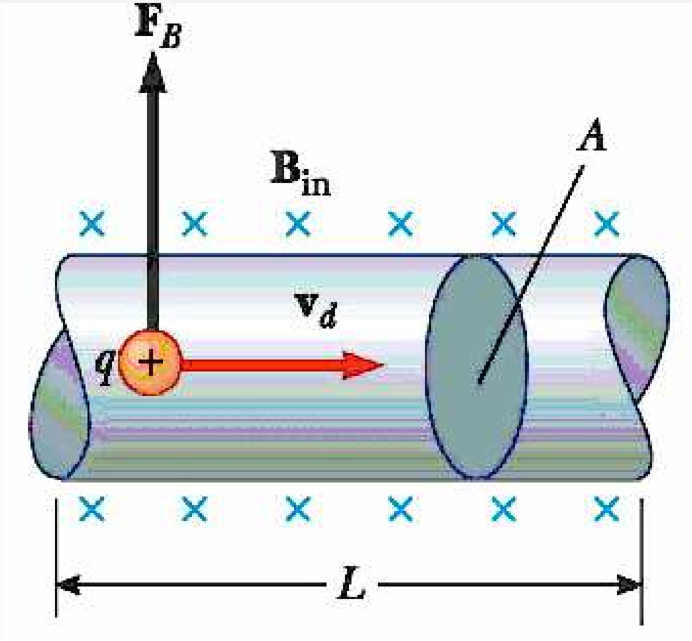
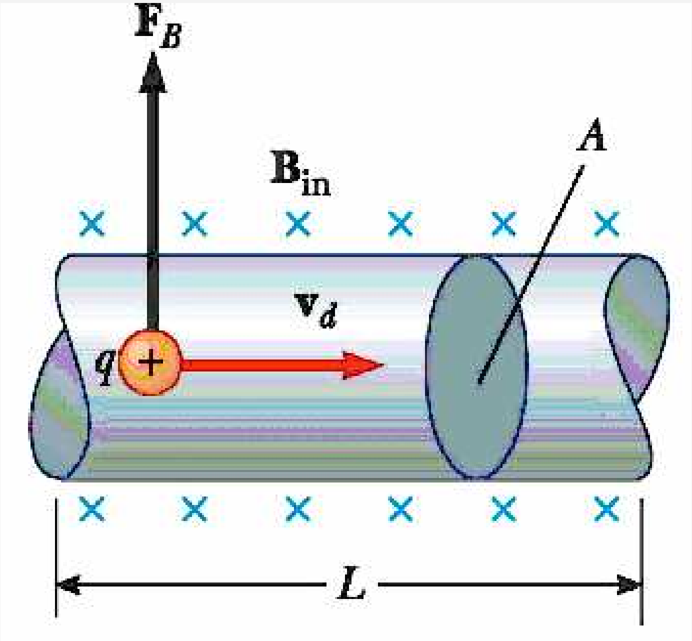


$$\vec{F}_B = I\,\vec{L}\times\vec{B}$$

- The vector $\vec{L}$ has magnitude L and is in the direction of current.
- What happens if the wire is not straight?

Force on Wires Carrying Current III



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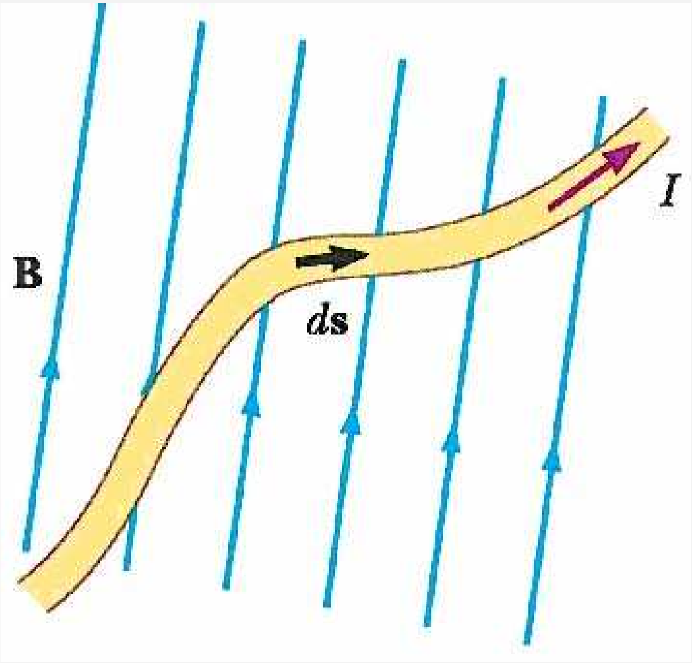
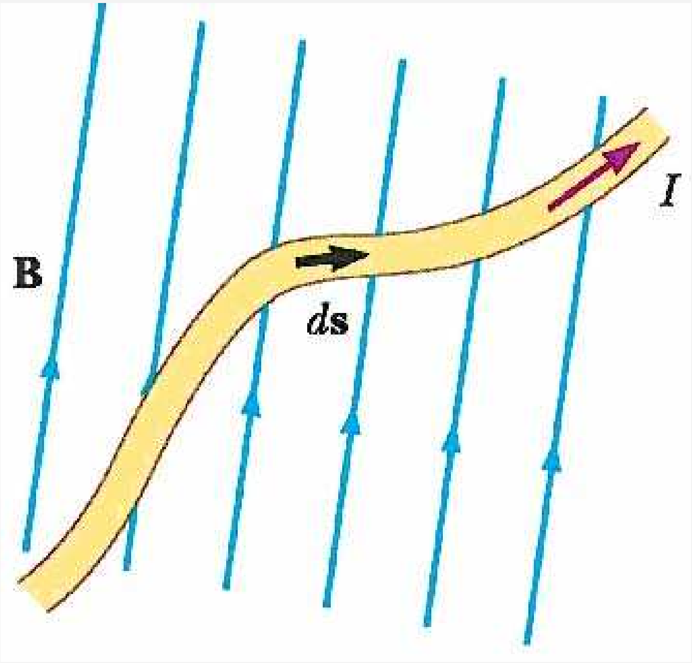
Force on Wires Carrying Current General



- We begin by breaking up the wire into very small pieces (so that the length of wire is approximately straight).

Force on Wires Carrying Current General



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$$d\vec{F}_B = I\, d\vec{s} \times \vec{B}$$

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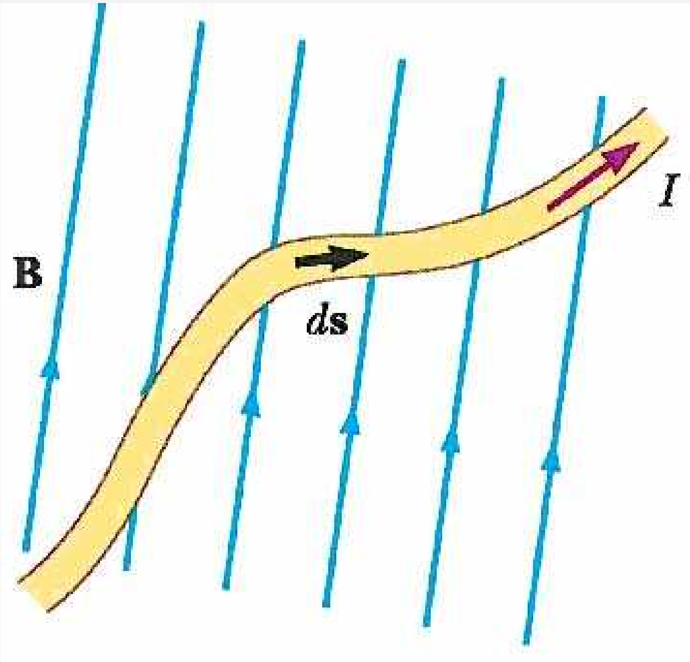

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$$d\vec{F}_B = I\, d\vec{s} \times \vec{B}$$

$$\Rightarrow \vec{F}_B = I \int (d\vec{s} \times \vec{B})$$