What if we have a series of charges all moving in the same direction? Like a current carrying wire?

- We already derived the equation for the current in a wire: $I = nAv_d q$
- And we know the magnetic force acting on *each individual charge* moving in the wire:
  $\vec{F}_B = q\vec{v} \times \vec{B}$
- However, what we want to know is the net magnetic force acting on all the charges moving in the wire. So, we need to use charge carrier density, n:
  $$n = \frac{\text{\# of charges}}{V} \Rightarrow \text{\# of charges} = nV = nAL$$
- Which we can use to get the magnetic force acting on *all the charges* moving in the wire:
  $$\vec{F}_B = \left(q\vec{v} \times \vec{B}\right) nAL = nAvq\vec{L} \times \vec{B}$$
- And we have derived the general equations for the magnetic force on a current carrying wire both for a straight wire and, using an integral, a wire that does not follow a straight path.
  $$\Rightarrow \vec{F}_B = I\vec{L} \times \vec{B} \Rightarrow \vec{F}_B = \int I\left(d\vec{L} \times \vec{B}\right) \quad \& \quad \|F_B\| = ILB\sin\theta$$
- You use the same wonderful right-hand rule to determine the direction of this force.