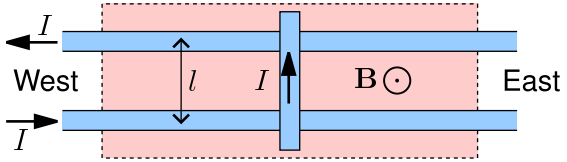
Tutorial 11 Question

- Ch 27: Pr. 56 (revised).
- Two stiff parallel wires a distance l apart in a horizontal plane act as rails to support a light metal rod of mass m ($\perp$ to each rail). A magnetic field $\mathbf{B}$, directed vertically upward, acts throughout. At $t = 0$, wires connected to the rails are connected to a constant current source and a current I begins to flow through the system. (*a*) What is the speed of the rod, starting from rest, as a function of time neglecting friction? (*b*) In which direction does the rod move if the current through it heads north?



Solution

- We need the direction of the force first, so let's do (*b*) now.

(*b*) In which direction does the rod move?

- The current through the rod is going north and the magnetic field is out of the page.
- From the right-hand force rule, the force is to the right, east.
- So the rod moves east.

(*a*) What is the speed of the rod as a function of time?

- We know the magnetic force is $\boxed{F = IlB_\perp}$ and $B_\perp = B$ because the B-field is already $\perp$ to the current,

$$F = IlB.$$

Solution, contd

(*a*) contd

- The acceleration is given by $F = ma$ so

$$a = \frac{F}{m} = \frac{IlB}{m}.$$

- The acceleration is constant, so the speed (integral of acceleration) is just

$$v = at = \frac{IlB}{m}t.$$

- Of course, friction and drag would prevent the speed from increasing linearly in practice. □