03-Motional EMF

Topics: Motional EMF

Summary: Goal is to familiarize students with motional EMF

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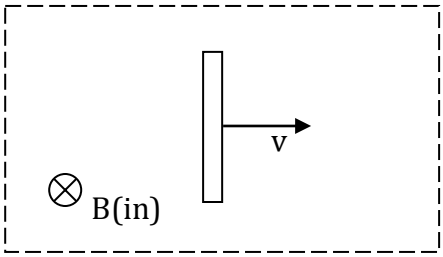
Comments: Page 1: Took about 10 minutes in class,
Part **1c** was difficult for many students and required instructor guidance for almost all groups, however, more guidance has been added, so students may not struggle as much next time.

Page 2: Took another 10 minutes, and there was still ~1/3 of the class not finished.
For part **d** there was some confusion about whether the force on the q is electric or magnetic (I think there is no E-field in this configuration, or at least it is small, and in any case it doesn't matter because it will contribute zero to this loop integral - it's a curl free E field because it's steady state current flow).

In part **f** a couple of the slower groups did not think much about the sign because they were anxious to finish, and required instructor questioning. One group was very pleased that the had derived emf = - d flux/ dt by themselves.

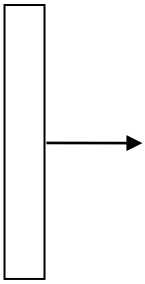
Motional EMF

A neutral metal bar is being pulled at constant velocity, speed v, to the right through a uniform magnetic field of magnitude B, as shown. The bar has been moving for some long time, and has achieved a dynamic steady-state.



(A) What is the magnetic force on charges in the bar (direction and magnitude)?

(B) In the diagram at right, sketch the distribution of charges in the bar.



(C) What is the electric field in the bar (direction and magnitude)? *Hint: remember that the bar has reached a dynamic steady-state.*

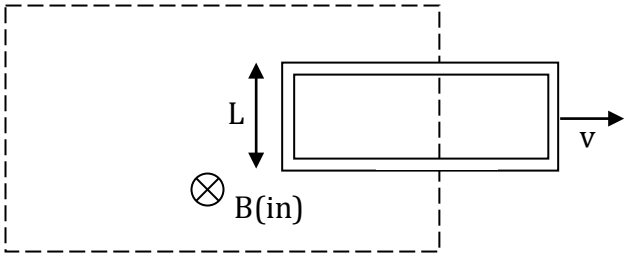
Motional EMF

Now consider a rectangular metal loop of height L, moving to the right with speed v, which is exiting a region with a constant magnetic field, magnitude B.

(D) The emf around any loop is defined as

$$emf = \oint \frac{\vec{F}_{on\,q}}{q} \cdot d\vec{l}$$.

What is the emf around the metal loop?



(E) What is the magnetic flux Φ through the metal loop? (Define any new symbols used.)

(F) Compute the time derivative of the flux through the loop dΦ/dt and compare with your computed emf. There is a +/- sign that you should worry about.