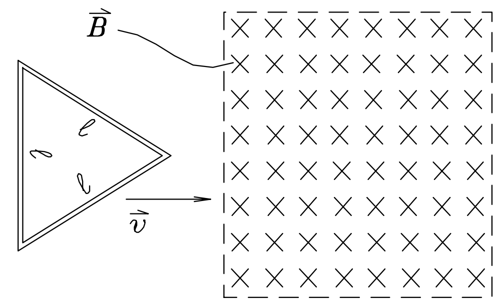
THE UNIVERSITY OF BRITISH COLUMBIA

Physics 108 Assignment # 8:
FARADAY & INDUCTANCE

Wed. 2 Mar. 2005 — finish by Wed. 9 Mar.

1. **Earth's-Field Generator**: What is the maximum $\mathcal{EMF}$ that can be induced in a circular coil of 5000 turns and radius 50 cm by rotating it 30 times per second in the Earth's magnetic field in Vancouver ($B = 5 \times 10^{-5}$ T)?

2. **Triangular Loop**: A wire loop in the shape of an equilateral triangle (length of a side $\ell = 0.2$ m) travelling at a constant speed $v = 5$ m/s moves, "pointy" end first, into a region where a uniform magnetic field $B = 0.4$ T points into the paper, as shown.

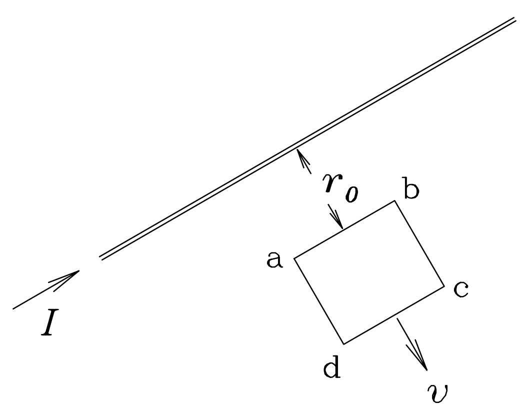


(*a*) Does current flow clockwise or counterclockwise (or not at all) around the triangular loop as it enters the field?

(*b*) What is the maximum induced $\mathcal{EMF}$ around the loop as it enters the field?

(*c*) Sketch the induced $\mathcal{EMF}$ around the loop as a function of time, from the time it begins to enter the field until it is entirely in the field.

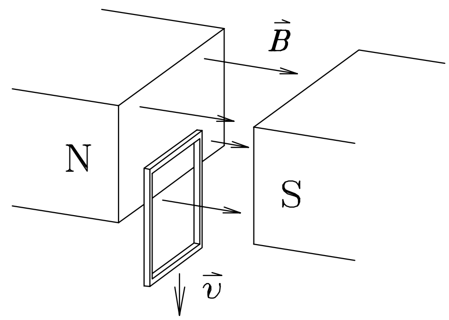
3. **Moving Loop in Non-Uniform Field**: A long, straight, stationary wire carries a constant current of 150 A. Nearby **abcd**, a square loop 12 cm on a side, is moving *away* from the stationary wire (in a direction perpendicular to the wire) at a speed of $v = 6$ m/s. The long wire and the sides of the loop are all in a common plane; the near (**ab**) and far (**cd**) sides of the loop are parallel to the long wire and the other two sides (**bc** and **da**) are perpendicular to it. The near side (**ab**) is initially $r_0 = 15$ cm away from the long wire. Calculate the $\mathcal{EMF}$ around the square loop at this instant, assuming that the resistance of the loop is large enough that any actual current flowing around it produces a negligible magnetic flux. Also indicate the *direction* of the small current in side **cd**.



Challenge Problem

for Extra Credit

[20 marks]



Dropping Frame: A square metallic frame is located, as shown, between the poles of an electromagnet, with its face perpendicular to $\vec{\boldsymbol{B}}$. The upper side is in a region of effectively uniform field with magnitude $B = 1.5$ T, while the lower side is outside the gap, where the field is essentially zero. If the frame is released and falls under its own weight, *determine the downward terminal velocity*. Assume the frame is made of aluminum (density 2.7 g/cm^3 and resistivity 2.8×10^{-6} Ω-cm). This problem requires careful thought. It is interesting that the terminal speed can be found with so little information about the metallic frame.