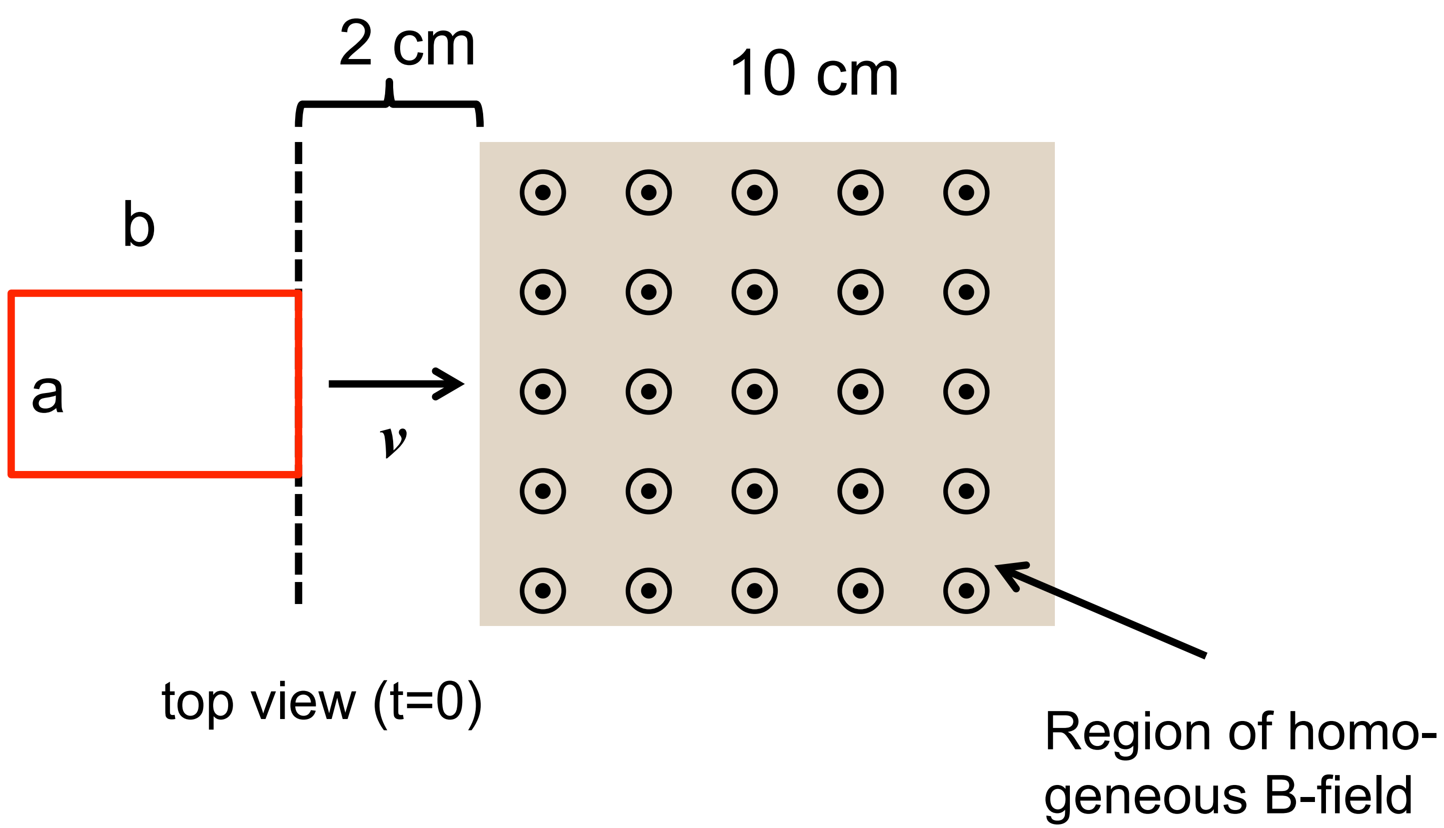
Problem

A square induction loop of dimensions a=2 cm and b=5 cm enters a homogeneous magnetic field B=2T at a velocity v = 1 cm/sec (see figure). Calculate the induced EMF as a function of time (magnitude and direction).



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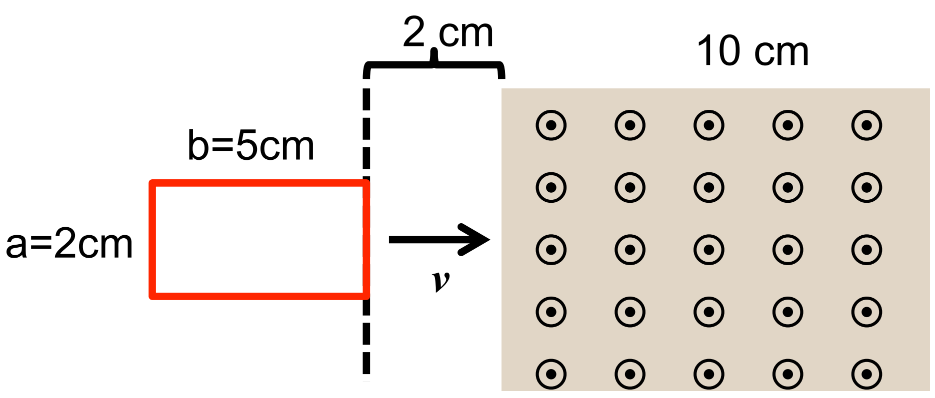
- First, let us define a direction for $\boldsymbol{A}$: out of the plane (i.e. || $\boldsymbol{B}$)
- Next, we calculate a few relevant times and associated magnetic fluxes:
  - The loop starts entering the magnetic field at t_1=2cm/v = 2s. Until then, $\phi_B=0$
  - The loop is completely inside the field at time t_2=7cm/v = 7s. At that time, ϕ_B=max=0.02m*0.05m*2T=2×10^{-3} Tm^2
  - The loop remains completely inside the field until t_3=12cm/v=12s. At that time, ϕ_B is still 2x10-3 Tm^2
  - The entire loop exits the field at t_4= 17cm/v=17s. Then, $\phi_B=0$

$$\phi_B = \int \boldsymbol{B} d\boldsymbol{A}$$



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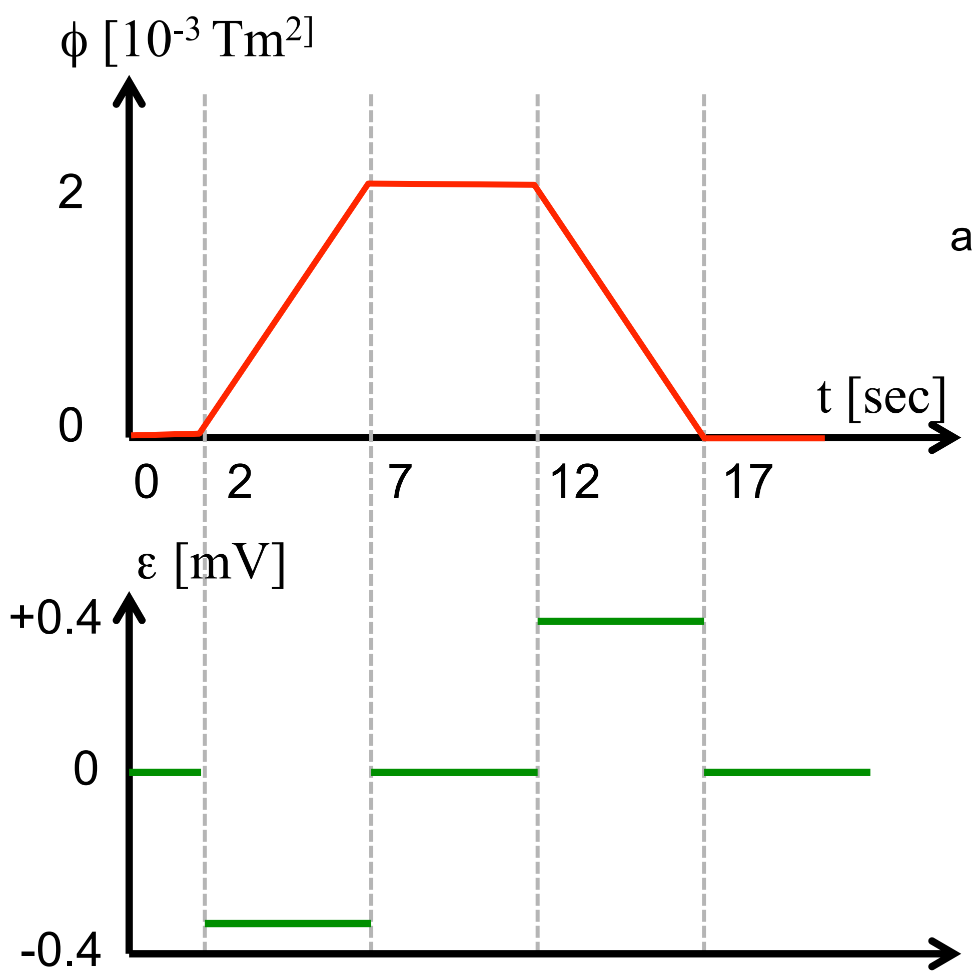

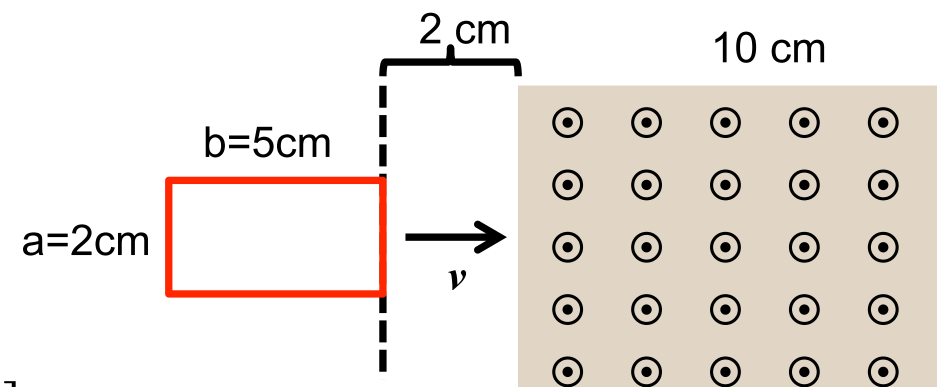

To find the induced EMF, we have to calculate -dϕ/dt, which is zero except for the 2nd and 4th time interval. We find

ε_2 = - 2x10^{-3}Tm^2/5s = -0.4 mV and

ε_2 = - (-2x10^{-3})Tm^2/5s = +0.4 mV, resp.

$$\varepsilon = -\frac{d\phi_B}{dt}$$

Problem

- A square induction loop of dimensions a = 2 cm and b=5 cm enters a homogeneous magnetic field B=2T at a velocity v = 1 cm/sec (see figure). Calculate the induced EMF as a function of time (magnitude and direction).

To find the direction of the induced EMF, we recall that we have assumed ***A*** to point out of the plane (i.e. in the same direction as B). Hence, a <u>negative EMF corresponds to clockwise (*cw*) current</u>, and a <u>positive EMF signifies anti-clockwise (*acw*) current.</u>