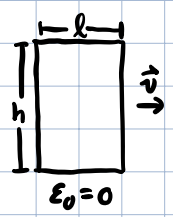
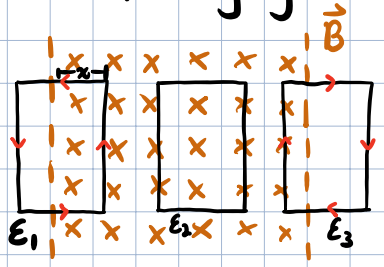
Electromagnetic Induction Examples

- Example: constant $\vec{B}$, changing $\vec{A}$



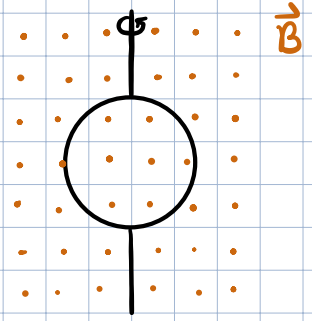


$$\mathcal{E}_1 = -\frac{d\Phi}{dt} = -\frac{d}{dt}(BA) = -B\frac{d}{dt}(A) = -Bh\frac{d}{dt}(x) = -Bhv$$

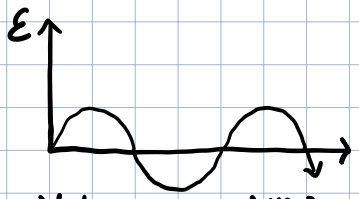
$$\mathcal{E}_2 = -\frac{d\Phi}{dt} = 0 \qquad \mathcal{E}_3 = Bhv$$

$$E = \frac{\mathcal{E}}{h} = Bv$$

- Example: constant $\vec{B}$, constant $\vec{A}$, changing θ



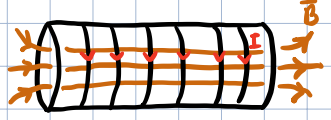
$$\mathcal{E} = -\frac{d\Phi}{dt} = -\frac{d}{dt}(BA\cos(\omega t)) = BA\omega\sin(\omega t)$$



AC current

For N loops, $\mathcal{E} = NBA\omega\sin(\omega t)$

Inductors: solenoid in AC circuit



Measures self inductance $L = \frac{N\Phi}{I}$ (# of coils × flux/coil), unit is Henry

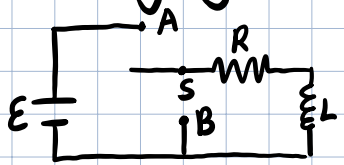
$$\frac{L}{\ell} = \frac{N\Phi}{\ell I} = \frac{NBA}{\ell I} = \frac{N\mu_0 \lambda I A}{\ell I} = \mu_0 \lambda^2 A$$

- What does this do?

$$LI = N\Phi \rightarrow L\frac{dI}{dt} = N\frac{d\Phi}{dt}, \quad \mathcal{E}_{inductor} = -N\frac{d\Phi}{dt} = -L\frac{dI}{dt}$$

So $\mathcal{E}$ is set up across inductor to oppose $\frac{dI}{dt}$

- Next, we're going to study RL (inductor + resistor) circuits



Switch in position A,

$$\mathcal{E} - IR - L\frac{dI}{dt} = 0 \ldots \text{continue next time}$$