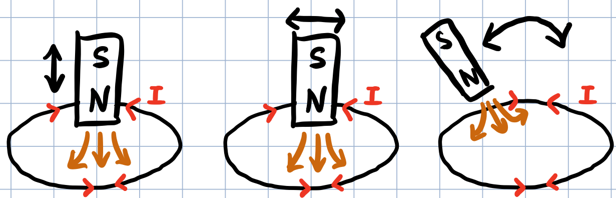
Electromagnetic Induction: generating electricity from magnetism

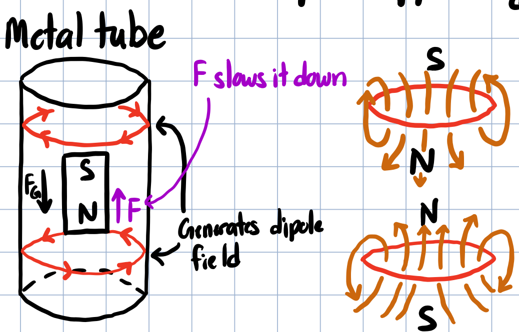
- If we move a magnet and a wire, we can generate electricity



- Magnetic flux is $\Phi_B = \int \vec{B} \cdot d\vec{A}$; the first two above have $\vec{B}$ changing and in the last one θ is changing
- We say that emf $\varepsilon = -\frac{d\Phi_B}{dt} = \oint \vec{E} \cdot d\vec{s} = -\frac{d}{dt}\int \vec{B} \cdot d\vec{A}$; Faraday's Law of Electromagnetic Induction

  comes from Lenz's Law

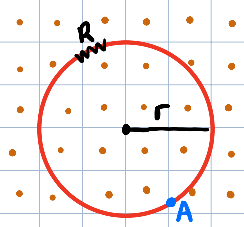
- Lenz's Law: ε is set up to oppose $\frac{d\Phi}{dt}$



So $\vec{E}$ goes clockwise

So $\vec{E}$ goes counter-clockwise

- Example:



$\vec{B} = (at^2 + bt + c)\hat{k}$

$a, b, c > 0$

$|\varepsilon| = \frac{d\Phi}{dt} = \frac{d}{dt}(BA\cos\theta) = \pi r^2 \frac{dB}{dt} = \pi r^2 (2at + b)$

To generate something to counter increase in flux, current must go clockwise

$I = \frac{\varepsilon}{R} = \frac{\pi r^2 (2at+b)}{R}$

$\varepsilon = \oint \vec{E} \cdot d\vec{s} = E \times 2\pi r \rightarrow E = \frac{\varepsilon}{2\pi r} = \frac{r(2at+b)}{2}$; E is non-static

If you start at A and go around and come back, $\Delta V = \varepsilon$ (not zero!)