Emf & Faradays lov

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

Elektrostatikk

$Q \xrightarrow{\text{genererer}} \vec{E}$ $\qquad$ $\frac{d\phi_B}{dt} \xrightarrow{\text{lager}} \vec{E}$

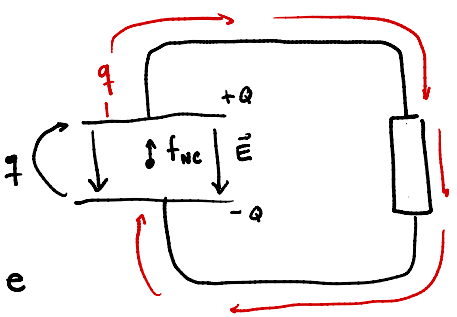
$I \xrightarrow{\text{lager}} \vec{B}$

Nytt begrep: emf

$$\oint q\vec{E} \cdot d\vec{l} = 0$$

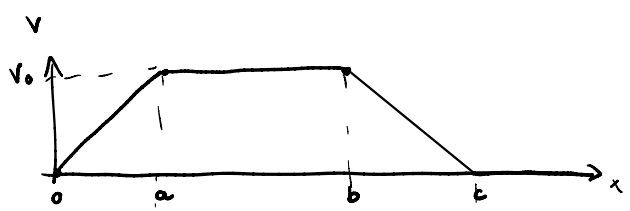
$$W = \oint (q\vec{E} + \vec{F}_{NC}) \cdot d\vec{l}$$

$$\oint_C (\vec{E} + \vec{f}_{NC}) \cdot d\vec{l} = \mathcal{E}$$



TEST

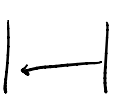
a) $\vec{E}$ inne i batteriet



$$E_x = -\frac{V_0}{a}$$

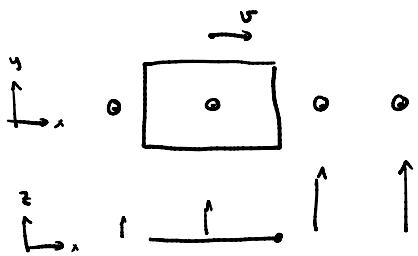


b) $\vec{F}_{netto} = 0$

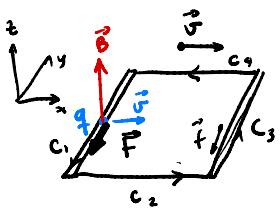


c) $\vec{f}_{NC} = ?$ $\qquad q\vec{E} + q\vec{f}_{NC} = 0 \Rightarrow \vec{f}_{NC} = -\vec{E} = \frac{V_0}{a}\hat{x}$

FARADAYS LOV



$$\vec{B} = \frac{B_0}{a} x \hat{z}$$



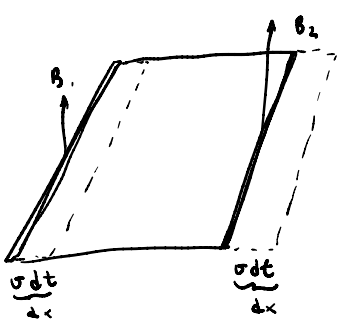
$$\vec{F} = q\vec{v} \times \vec{B}$$

$$\vec{f} = \vec{v} \times \vec{B}$$

$$e = \oint_c (\vec{f}_{NC} + \vec{E}) \cdot d\vec{l}$$

$$= \oint_c (\vec{v} \times \vec{B}) \cdot d\vec{l} = \int_{C_1} + \underbrace{\int_{C_2}}_{0} + \int_{C_3} + \underbrace{\int_{C_4}}_{0}$$

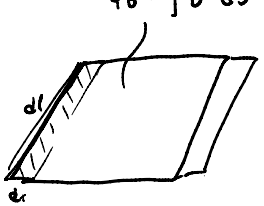
$$e = vB_1 l - vB_2 l$$



$$e = \int_{C_1} \underbrace{v}_{\frac{dx}{dt}} B_1 \, dl + \int_{C_3} v B_2 \, dl$$

$$\frac{1}{dt} \int_{C_1} dx B_1 dl - \frac{1}{dt} \int_{C_3} dx B_2 dl$$

$$\Phi_B = \int \vec{B} \cdot d\vec{S}$$



$$e_c = \frac{1}{dt}(-d\phi_B) = -\frac{d\phi_B}{dt}$$



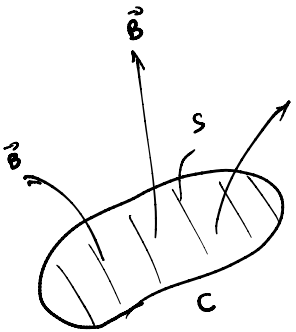
$$\phi_B = \int_S \vec{B}\cdot d\vec{S}$$



FARADAYS LOV

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

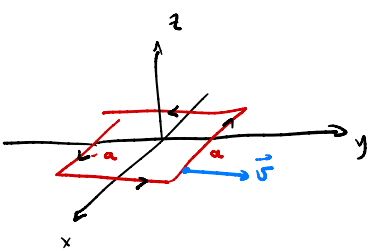
$$\phi_B = \int_S \vec{B}\cdot d\vec{S}$$



$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

TEST

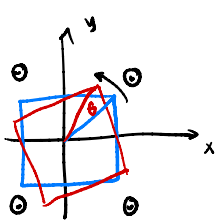
$\vec{B} = B_0\hat{z}$



$\frac{d\phi_B}{dt} = ?$

$$\phi_B = \int_S \vec{B}\cdot d\vec{S} = a^2 \cdot B_0$$

$\frac{d\phi_B}{dt} = ?$



$\vec{B} = B_0\hat{z}$

$\phi_B = a^2 B_0$

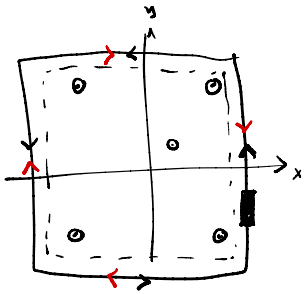
TEST

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

$\phi_B > 0$

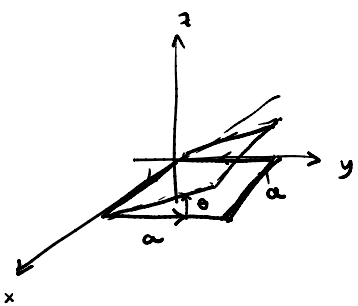
$\frac{d\phi_B}{dt} < 0$

$$e = -\frac{d\phi_B}{dt} > 0$$

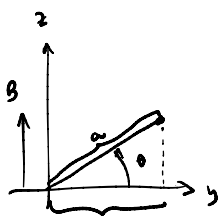


$$e = \oint (f_{NCF}\,\vec{E}) \cdot d\vec{l} > 0$$

$$e = +IR > 0$$



$\vec{B} = B_0\hat{z}$



$$e = -\frac{d\phi_B}{dt} = ?$$

$$\phi_B = \int_S \vec{B} \cdot d\vec{S} = \vec{B} \cdot \vec{S}$$

$$= a \cdot a \cdot \cos\theta \cdot B_0$$

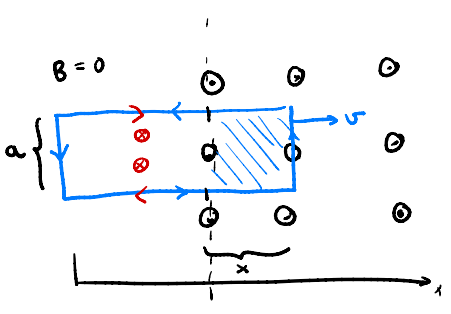
$$e = -\frac{d\phi_B}{dt} = +a^2 \sin\theta \cdot B_0 \cdot \frac{d\theta}{dt}\phi_B = a^2 B_0 \cos\theta$$

TEST

$$e = a^2 B_0 \sin\theta \cdot \frac{d\theta}{dt}$$

$\phi_B = ?$

$e = ?$



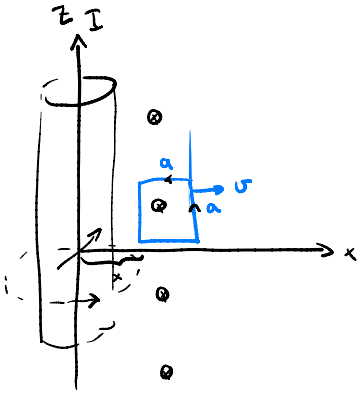
Sylinder-koord:

$$\oint_C \vec{B}\cdot d\vec{l} = \mu_0 I$$

$$\vec{B} = B_\varphi(r)\,\hat{\varphi}$$

$$2\pi r B_\varphi = \mu_0 I$$

$$B_\varphi = \frac{\mu_0 I}{2\pi r}$$



$$\Phi_B = \int \vec{B}\cdot d\vec{S}$$

$$= \int_0^a \int_x^{x+a} \frac{\mu_0 I}{2\pi x}\, dx\, dz$$

$$= -\frac{\mu_0 I a}{2\pi} \int_x^{x+a} \frac{1}{x}\, dx$$

$$\Phi_B = -\frac{\mu_0 I a}{2\pi}\left[\ln(x+a) - \ln x\right]$$

$$x = vt$$

$$\Phi_B = -\frac{\mu_0 I a}{2\pi}\left[\ln(vt+a) - \ln vt\right]$$

$$e = -\frac{d\Phi_B}{dt} = \frac{\mu_0 I a}{2\pi}\left[\frac{v}{vt+a} - \frac{v}{vt}\right]$$