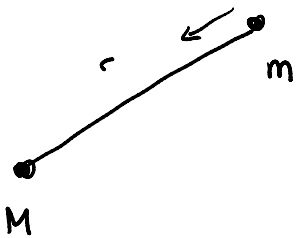
# ELEKTRISK FELT

## Newtons gravitasjonslov

$$\vec{F}_{\text{fra } M \text{ på } m} = \gamma \frac{mM}{r^2} \hat{u} = -\hat{R}$$

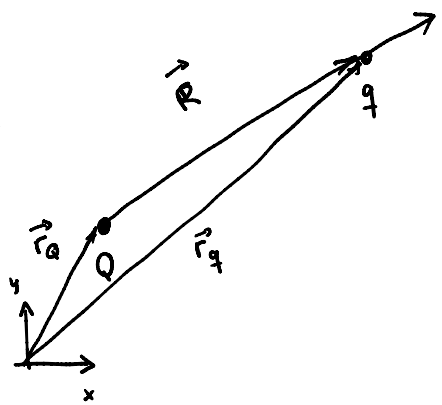



## Coloumbs lov

$$\vec{F}_{\text{fra } Q \text{ på } q} = \frac{1}{4\pi\epsilon_0} \frac{qQ}{r^2} \hat{R}$$

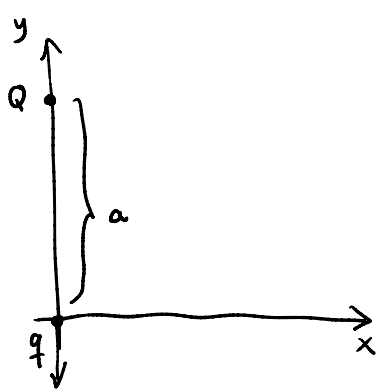
$$= \frac{1}{4\pi\epsilon_0} \frac{qQ}{R^2} \hat{R}$$

$$\hat{R} = \frac{\vec{R}}{R}, \quad R = |\vec{R}|$$




**Test 1**

$\vec{F}$ på q?




$$\vec{F}_{\text{fra } Q \text{ på } q} = \frac{1}{4\pi\epsilon_0} \frac{qQ}{R^2} \hat{R}$$

$$= \frac{1}{4\pi\epsilon_0} \frac{qQ}{a^2} (-\hat{y})$$

$$= \frac{1}{4\pi\epsilon_0} \frac{qQ}{a^2} (0, -1, 0)$$

# Test 2

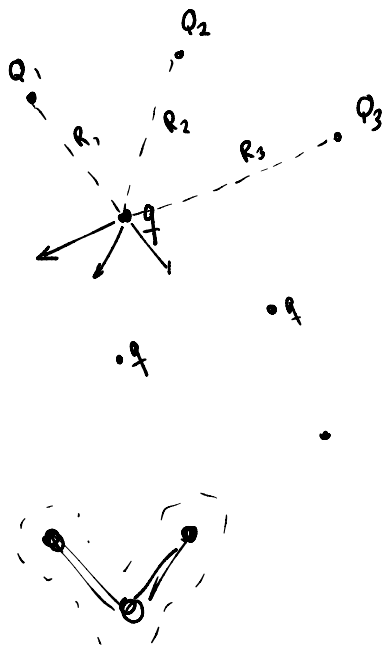



Tegn kreftene

$$\vec{F} = \frac{qQ}{4\pi\epsilon_0}\frac{\hat{R}}{R^2}$$

$\vec{R}$ fra ladning til der hvor kraften virker

## Superposisjonsprinsippet



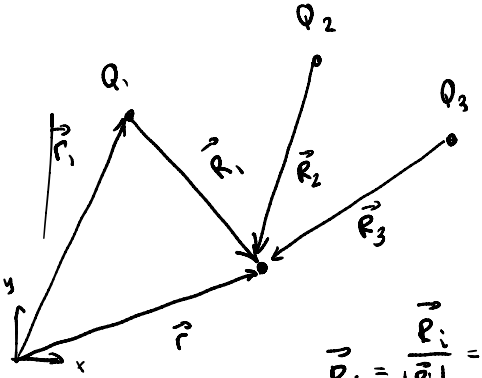

$$\vec{F}_{\text{på } q} = \sum_i \vec{F}_{\text{fra } Q_i \text{ på } q}$$

$$= \sum_i \frac{qQ_i}{4\pi\epsilon_0}\frac{\hat{R}_i}{R_i^2}$$

$$= q \underbrace{\sum_i \frac{Q_i}{4\pi\epsilon_0}\frac{\hat{R}_i}{R_i^2}}$$

$$\vec{E} = \frac{\vec{F}_q}{q}$$

$\vec{R}$ - vektor




$$\vec{R}_i = \vec{r} - \vec{r}_i$$

$$\vec{F}_{\text{á}q} = \sum_i \frac{qQ_i}{4\pi\epsilon_0}\frac{\hat{R}_i}{R_i^2}$$

$$= q\sum_i \frac{Q_i}{4\pi\epsilon_0}\frac{\hat{R}_i}{R_i^2}$$

$$\vec{F} = q\underbrace{\sum_i \frac{Q_i}{4\pi\epsilon_0}\frac{(\vec{r}-\vec{r}_i)}{|\vec{r}-\vec{r}_i|^3}}_{\vec{E}(\vec{r})}$$

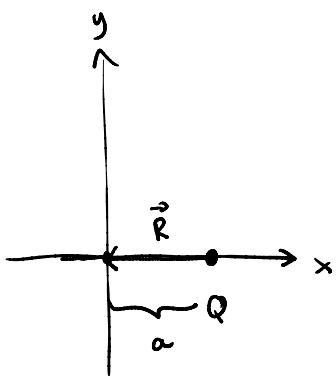
$$\vec{R}_i = \frac{\vec{R}_i}{|\vec{R}_i|} = \frac{\vec{R}_i}{R_i}$$

$$\frac{\hat{R}_i}{R_i^2} = \frac{\vec{R}_i}{R_i}\frac{1}{R_i^2} = \frac{\vec{R}_i}{R_i^3}$$

**Test**

$\vec{E}(\vec{0}) = ?$

- Hva er $\vec{R}$?




$$\vec{R} = \vec{r} - \vec{r}_i = \vec{0} - a\hat{x}$$

$$= -a\hat{x}$$

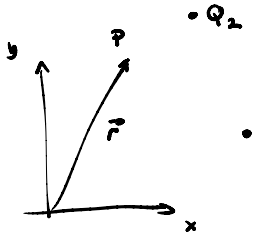
$$= (0,0) - (a,0) = (-a,0)$$

$$\vec{E} = \frac{Q}{4\pi\epsilon_0}\frac{\hat{R}}{R^2} = \frac{Q}{4\pi\epsilon_0}\frac{\vec{R}}{R^3}$$

$$\vec{E}(\vec{0}) = \frac{Q}{4\pi\epsilon_0}\frac{-a\hat{x}}{a^3} = -\frac{Q}{4\pi\epsilon_0 a^2}\hat{x}$$

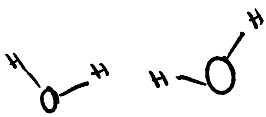
# ELEKTRISK FELT

$$\vec{E}(\vec{r}) = \frac{Q}{4\pi\epsilon_0}\frac{\hat{R}}{R^2}$$



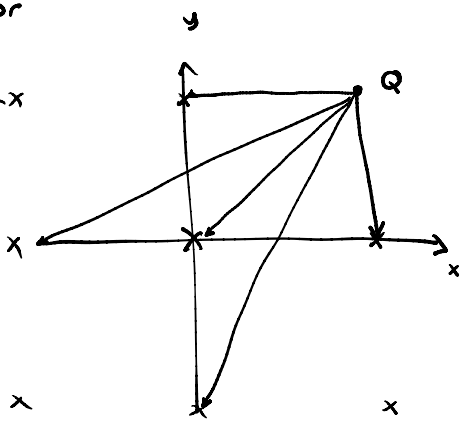

Superposisjon:

$$\vec{E}(\vec{r}) = \sum_{i=1}^{N} \frac{Q_i}{4\pi\epsilon_0}\frac{\hat{R}_i}{R_i^2}$$




**Fest 1** $\vec{R}$ - vektor

Hvor er $\vec{R}$-vektor



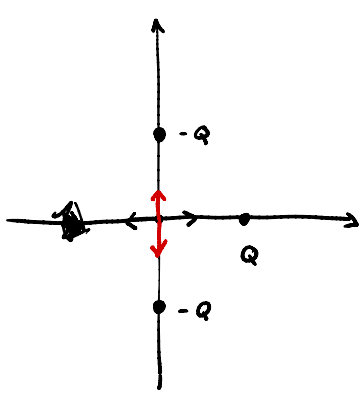

Hvor er $|\vec{E}|$ størst?

$\vec{R}_i = \vec{r} - \vec{r}_i$

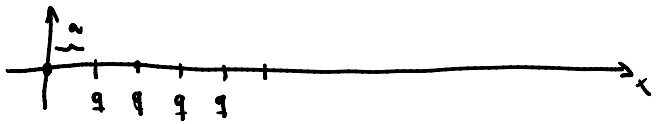
$\vec{E} = \frac{Q}{4\pi\epsilon_0}\frac{\hat{R}}{R^2}$

**Test**

$\vec{E}(0) = ?$



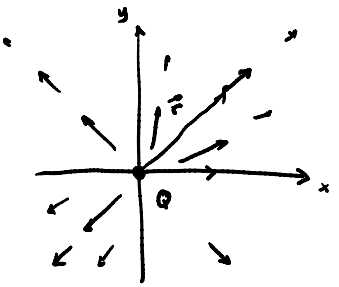
$\vec{E}(0) = ?$



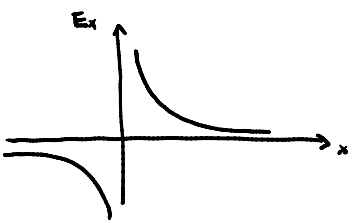

**Visualisering**

$$\vec{E} = \frac{Q}{4\pi\epsilon_0}\frac{\vec{R}}{R^3}$$

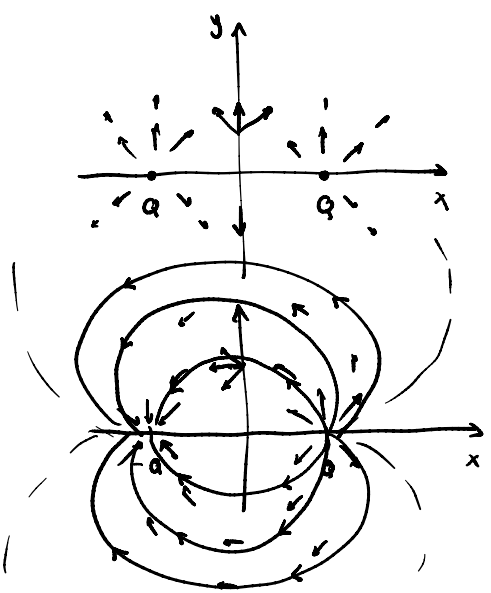
$$= \frac{Q}{4\pi\epsilon_0}\frac{1}{r^2}\hat{r}$$




$$\vec{E}(x,0) = \frac{Q}{4\pi\epsilon_0}\frac{1}{x^2}\frac{\vec{x}}{|\vec{x}|}$$



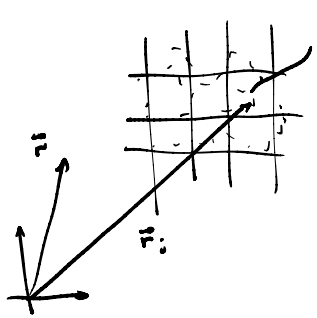

**Test**



$$\vec{E} = \sum_i \frac{Q_i}{4\pi\epsilon_0} \frac{\hat{R}_i}{R_i^2}$$

$$= \sum_i \frac{\Delta q_i}{4\pi\epsilon_0} \frac{\hat{R}_i}{R_i^2}$$

$$= \sum_i \frac{\rho_i \, \Delta v_i}{4\pi\epsilon_0} \frac{\hat{R}_i}{R_i^2}$$

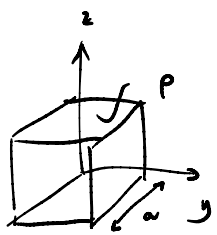



$$\Delta q_i = \rho_i \Delta v$$

$$\rho_i = \frac{\Delta q_i}{\Delta v}$$

$$\vec{E}(\vec{r}) = \int_v \frac{\rho}{4\pi\epsilon_0} \frac{\hat{R}}{R^2} \, dv = \int_v \frac{\rho(\vec{r}')}{4\pi\epsilon_0} \frac{(\vec{r} - \vec{r}')}{|\vec{r} - \vec{r}'|^3} \, dv'$$

**Test**




$$\vec{E}(x,0,0) =$$

$$\int_0^a \int_0^a \int_0^a \frac{\rho(x',y',z')(x - x', -y', -z')}{4\pi\epsilon_0 \left((x-x')^2 + (-y')^2 + (-z')^2\right)^{3/2}} \, dx' dy' dz'$$

Romladning | Overflateladning | Linjeladning









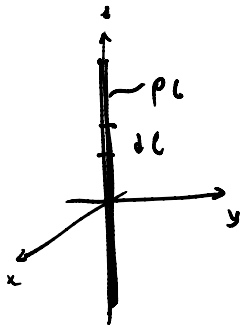

$$\vec{E} = \int \frac{\rho_v \, dv}{4\pi\epsilon_0} \frac{\hat{R}}{R^2}$$

$$\vec{E} = \int \frac{\rho_s \, dS}{4\pi\epsilon_0} \frac{\hat{R}}{R^2}$$

$$\vec{E} = \int \frac{\rho_l \, dl}{4\pi\epsilon_0} \frac{\hat{R}}{R^2}$$

**Eksempel**

$$d\vec{E} = \frac{\rho_l dl}{4\pi\epsilon_0} \frac{\vec{R}}{R^3}$$




$$\vec{r} = (x, y, z) \qquad \vec{r}' = (0, 0, z')$$

$$\vec{R} = \vec{r} - \vec{r}' = (x, y, z - z')$$

$$d\vec{E} = \frac{\rho \overrightarrow{dl}^{dz'}}{4\pi\epsilon_0} \frac{(x, y, z - z')}{(x^2 + y^2 + (z - z')^2)^{3/2}}$$

$$\vec{E} = \int d\vec{E} = \int \frac{\rho}{4\pi\epsilon_0} \frac{(x, y, z - z')}{(x^2 + y^2 + (z - z')^2)^{3/2}} dz'$$