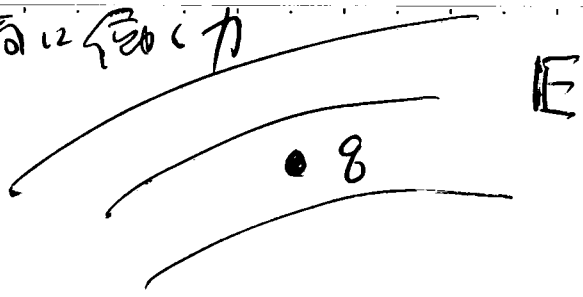
# 8. 物体に働く静電気力

No.

Date 06.

## 8-1 電荷に働く力

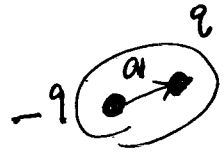



$$\boxed{\mathbf{F} = q\mathbf{E}}$$

$\mathbf{E} = -\nabla\phi$ より $\boxed{U = q\phi}$ とおくと

$$\boxed{\mathbf{F} = -q\nabla\phi = -\nabla U}$$

## 8-2 電気双極子に働く力




$\mathbf{E}$

$$U = -q\phi(r) + q\phi(r+a)$$

$|r| \gg |a|$ より

$$U = -q\phi(r) + q\phi(r) + q(\nabla\phi)\cdot a + \cdots$$

$$\therefore \boxed{U = -\mathbf{p}\cdot\mathbf{E}} \quad (\mathbf{p} = q\mathbf{a}) \quad (\mathbf{E} = -\nabla\phi)$$

力は $\boxed{\mathbf{F} = -\nabla U}$

No.

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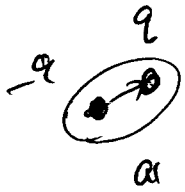
$\mathbf{F}$ を電場で表すと




$$\mathbf{F} = -q\mathbf{E}(\mathbf{r}) + q\mathbf{E}(\mathbf{r}+\mathbf{a})$$

$$F_x = -qE_x + qE_x + q\,\mathbf{a}\cdot\nabla E_x$$

$$\therefore\ F_x = q a \nabla E_x = \mathbf{p}\cdot\nabla E_x$$

$\mathbf{p}$ は定数に注意

$\mathbf{E} = -\nabla\phi$ より

$$F_x = \nabla(\mathbf{p}\cdot\mathbf{E}_x) = -\nabla\cdot(\mathbf{p}\,\nabla_x\phi)$$

$$= -\nabla_x\left((\nabla\cdot\mathbf{p})\phi\right) = -\nabla_x\left((\nabla\phi)\cdot\mathbf{p}\right)$$

$$= \nabla_x(\mathbf{p}\cdot\mathbf{E})$$

$$= -\nabla_x U \quad \leftarrow \boxed{U = -\mathbf{p}\cdot\mathbf{E}}$$

$$\therefore\ \boxed{\mathbf{F} = -\nabla U}$$

証明終了