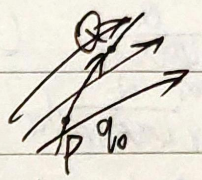
静电场中的电势

2.1 静电场具有保守性.

$$\oint \vec{E}\,d\vec{l} = 0.$$

2.2 静电势能 电势

$$A_{PQ} = W_P - W_Q = q_0\int_P^Q \vec{E}\,d\vec{l}$$



$W_P = A_{PQ} = q_0\int_P^Q \vec{E}\,d\vec{l}$ $(W_Q=0)$ 取Q点为零电势.

$W_P = A_{P\infty} = q_0\int_P^\infty \vec{E}\,d\vec{l}$ $(W_\infty=0)$ 取无穷远处为零电势.

$\frac{W_P}{q_0} = \frac{A_{PQ}}{q_0} = \int_P^Q \vec{E}\,d\vec{l} = U_P$ $(U_Q=0)$

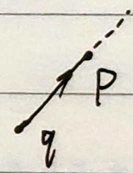
$\frac{W_P}{q_0} = \frac{A_{P\infty}}{q_0} = \int_0^\infty \vec{E}\,d\vec{l} = U_P$ $(U_\infty=0)$.

电势差：$U_{PQ} = U_P - U_Q = \int_P^\infty \vec{E}\,d\vec{l} - \int_Q^\infty \vec{E}\,d\vec{l} = \int_P^Q \vec{E}\,d\vec{l}$

电势力功 $A_{PQ} = q_0\int_P^Q \vec{E}\,d\vec{l} = q_0 U_{PQ} = q_0(U_P-U_Q) = W_P - W_Q$

2.3 电势的计算.

$U_P = \int_P^\infty \vec{E}\,d\vec{l} = \int_r^\infty \frac{q}{4\pi\varepsilon_0 r^2}\,dr$



$U_P = \frac{q}{4\pi\varepsilon_0 r}$

① $q>0, U_P>0$, $r\uparrow$, $U_P\downarrow$, $r\to\infty$, $U_P=0$

② $q<0, U_P<0$, $r\uparrow$, $U_P\downarrow$, $r\to\infty$, $U_P=0$

$U_P = \int_P^\infty \vec{E}\,d\vec{l} = \int_P^\infty (\Sigma \vec{E}_i)\,d\vec{l} = \int_P^\infty \vec{E}_1\,d\vec{l} + \int_P^\infty \vec{E}_2\,d\vec{l} + \cdots + \int_P^\infty \vec{E}_i\,d\vec{l}$

$= \frac{q_1}{4\pi\varepsilon_0 r_1} + \frac{q_2}{4\pi\varepsilon_0 r_2} + \cdots + \frac{q_i}{4\pi\varepsilon_0 r_i}$

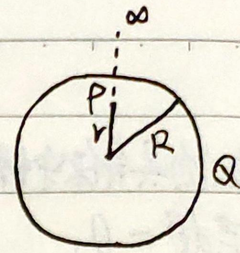
$\therefore U_P = \sum_{i=1}^{n} \frac{q_i}{4\pi\varepsilon_0 r_i} = \sum_{i=1}^{n} U_i$ (代数和).

$dU = \frac{dq}{4\pi\varepsilon_0 r}$

$U = \int dU = \int \frac{dq}{4\pi\varepsilon_0 r}$

2.4. 电势梯度 (略).

Date.　　/



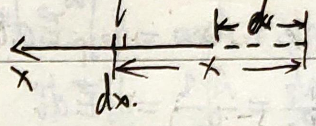
例 $E=\begin{cases} 0, & r<R \\ \dfrac{Q}{4\pi\varepsilon_0 r^2}, & r>R \end{cases}$

$$U_P=\int_P^\infty \vec{E}\cdot d\vec{l}=\int_r^R \vec{E}\cdot d\vec{l}+\int_R^\infty \vec{E}\cdot d\vec{l}$$

$$=\int_R^\infty \frac{Q}{4\pi\varepsilon_0 r^2}dr$$

$$=\frac{Q}{4\pi\varepsilon_0 R}\quad (r<R).$$

$$U_P=\int_r^\infty \frac{Q}{4\pi\varepsilon_0 r^2}dr=\frac{Q}{4\pi\varepsilon_0 r}\ (r>R).$$



例. $dq=\lambda dx.$

$$U=\int dU=\int_d^{d+l}\frac{\lambda dx}{4\pi\varepsilon_0 x}=\frac{\lambda}{4\pi\varepsilon_0}\ln\frac{d+l}{d}.$$