电力与电场

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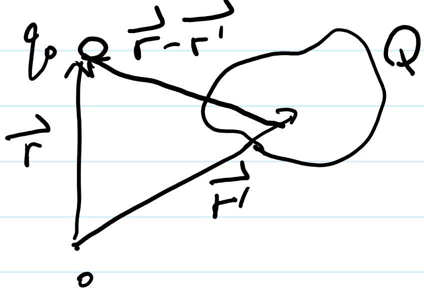
1.1 库仑定律的数学公式 $F_{12} = k\frac{q_1 q_2}{r_{12}^2}\vec{e_{12}}$ 2对1的作用力

1.2 叠加原理 $\vec{F_i} = \sum_{j\neq i}\frac{q_i q_j}{4\pi\varepsilon_0 r_{ij}^2}\vec{e_{ij}}$

1.3 体带电体对点电荷的作用力 $\vec{F} = \frac{q_0}{4\pi\varepsilon_0}\iiint_V \frac{\rho(\vec{r}')}{|\vec{r}-\vec{r}'|^3}(\vec{r}-\vec{r}')dV'$

1.4 静止的带电体对静止的带电体的作用力



$\vec{F} = \frac{1}{4\pi\varepsilon_0}\iiint_V\iiint_{V'}\frac{\rho(\vec{r})\rho'(\vec{r}')}{|\vec{r}-\vec{r}'|^3}(\vec{r}-\vec{r}')dV dV'$

$\vec{F_0} = q_0\vec{E}(r)$

1.5 电场强度定义式 $\vec{E}(r) = \frac{\vec{F_0}}{q_0}$

1.6 位于原点的点电荷的电场 $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\vec{e_r}$

1.7 空间点电荷体系产生的电场 $\vec{E}(r) = \sum_i\vec{E_i}(r) = \sum_i\frac{1}{4\pi\varepsilon_0}\frac{q_i}{|\vec{r}-\vec{r_i}|^3}(\vec{r}-\vec{r_i})$

1.8 电荷元产生的电场 $d\vec{E}(r) = \frac{dq}{4\pi\varepsilon_0|\vec{r}-\vec{r}'|^3}(\vec{r}-\vec{r}')$

1.9 带电体在空间的电场 $\vec{E}(r) = \frac{1}{4\pi\varepsilon_0}\iiint_V\frac{\rho(\vec{r}')}{|\vec{r}-\vec{r}'|^3}(\vec{r}-\vec{r}')dV'$

$\frac{\Delta N}{\Delta S_\perp} = E$

1.10 电通量的定义 $\Phi = \iint_S E\cos\theta dS = \iint_S\vec{E}\cdot d\vec{S}$

1.11 电通量的特点 $\Phi = \iint\vec{E}\cdot d\vec{S} = \iint\sum\vec{E_i}\cdot dS = \sum_i\iint\vec{E_i}\cdot d\vec{S} = \sum_i\Phi_i$ (叠加原理)

$d\Phi = \vec{E}\cdot d\vec{S} = \frac{q}{4\pi\varepsilon_0}\frac{\vec{e_r}\cdot d\vec{S}}{r^2}$

$d\Omega = \frac{dS_0}{r^2} = \frac{\vec{e_r}\cdot d\vec{S}}{r^2}$

$\frac{\vec{e_r}\cdot d\vec{S_1}}{r_1^2} = \frac{\vec{e_r}\cdot d\vec{S_2}}{r_2^2}$

$\Phi = \iint_S\vec{E}\cdot d\vec{S} = \frac{q}{4\pi\varepsilon_0}\iint_S d\Omega$

$\Phi = \oint_S\vec{E}\cdot d\vec{S} = \frac{q}{\varepsilon_0}$

$$\Phi=\iint_S \vec{E}\cdot d\vec{S}=0$$

$$\oiint_S \vec{E}\cdot d\vec{S}=\oiint_S \sum_i \vec{E_i}\, d\vec{S}=\sum_i \oiint_S \vec{E_i}\cdot d\vec{S}=\sum_i^{S内}\frac{q_i}{\varepsilon_0}$$

1.12 高斯定理 $\oiint_S \vec{E}\cdot d\vec{S}=\frac{1}{\varepsilon_0}\sum_i^{S内} q$

1.13 有体分布电荷的高斯定理 $\oiint_S \vec{E}\cdot d\vec{S}=\frac{1}{\varepsilon_0}\iiint_V \rho\, dV$

1.14 数学上的高斯定理 $\oiint_S \vec{A}\cdot d\vec{S}=\iiint_V \nabla\cdot\vec{A}\, dV$

1.15 微分形式的高斯定理 $\nabla\cdot\vec{E}=\frac{\rho}{\varepsilon_0}$

1.16 直角坐标系中的"∇"运算符 $\nabla=\vec{e_x}\frac{\partial}{\partial x}+\vec{e_y}\frac{\partial}{\partial y}+\vec{e_z}\frac{\partial}{\partial z}$

1.17 球坐标系中的"∇"运算符 $\nabla=\vec{e_r}\frac{\partial}{\partial r}+\vec{e_\theta}\frac{1}{r}\frac{\partial}{\partial\theta}+\vec{e_\varphi}\frac{1}{r\sin\theta}\frac{\partial}{\partial\varphi}$

若 $f\propto\frac{1}{r^{2+\delta}}$

$E\propto f\propto\frac{1}{r^{2+\delta}}$

$\Phi=\oiint_S \vec{E}\cdot d\vec{S}=\frac{1}{4\pi\varepsilon_0}\oiint\frac{1}{r^\delta}d\Omega$

$\Phi=\Phi(r)$

1.18 匀速直线运动的点电荷的场 $\vec{E}=\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\frac{1-\beta^2}{(1-\beta^2\sin^2\theta)^{\frac{3}{2}}}\vec{e_r}$

($\beta=\frac{v}{c}$，c是光速)

1.19 一个点电荷在另一个点电荷的电场中移动时静电场所做的功

$$A=q_0\int_P^Q \vec{E}\cdot d\vec{l}=\frac{q_0q}{4\pi\varepsilon_0}\int_P^Q\frac{\vec{r}}{r^3}\cdot d\vec{l}=\frac{q_0q}{4\pi\varepsilon_0}\int_P^Q\frac{dr}{r^2}=\frac{}{4\pi\varepsilon_0}\quad r_P-r_Q)$$

$$A=\oint_L q_0\vec{E}\cdot d\vec{l}=\frac{q_0q}{4\pi\varepsilon_0}\oint_L\frac{\vec{r}}{r^3}d\vec{l}=\frac{q_0q}{4\pi\varepsilon_0}\oint_L\frac{dr}{r^2}=-\frac{q_0q}{4\pi\varepsilon_0}\left(\frac{1}{r}\right)\Big|_{r_P}^{r_P}=0$$

1.20 静电场的环路定理 $\oint_L \vec{E}\cdot d\vec{l}=0$

$$\oint_L \vec{E}\cdot d\vec{l}=\iint_S \nabla\times\vec{E}\cdot d\vec{S}$$

1.21 静电场环路定理的微分形式 $\nabla\times\vec{E}=0$

$$A_{PQ}=W_{PQ}=W_{PQ}=q_0\int_P^Q \vec{E}\cdot d\vec{l}$$

1.22 电荷在空间一点的电势能 $W_p = W_{p\infty} = q_0\int_p^{\infty}\vec{E}\cdot d\vec{l} = -q_0\int_{\infty}^{p}\vec{E}\cdot d\vec{l}$

1.23 电势差定义 $U_{pQ} = \frac{W_{pQ}}{q_0} = \int_p^Q \vec{E}\cdot d\vec{l}$

1.24 电场中某点的电势 $U(P) = \int_P^{\infty}\vec{E}\cdot d\vec{l} = -\int_{\infty}^{P}\vec{E}\cdot d\vec{l}$

$$\int_P^Q \vec{E}\cdot d\vec{l} = \int_P^{\infty}\vec{E}\cdot d\vec{l} + \int_{\infty}^{Q}\vec{E}\cdot d\vec{l} = \int_P^{\infty}\vec{E}\cdot d\vec{l} - \int_Q^{\infty}\vec{E}\cdot d\vec{l}$$

1.25 电势差与电势的关系 $U_{pQ} = U(P) - U(Q)$

1.26 点电荷产生的电场的电势

$$U(r) = \int_r^{\infty}\vec{E}\cdot d\vec{l} = \int_r^{\infty}\frac{q}{4\pi\varepsilon_0}\frac{\vec{r}}{r^3}\cdot d\vec{l} = \frac{q}{4\pi\varepsilon_0}\int_r^{\infty}\frac{dr}{r^2} = \frac{q}{4\pi\varepsilon_0 r}$$

1.27 点电荷体系产生的电势

$$U(r) = \int_r^{\infty}\vec{E}\cdot d\vec{l} = \int_r^{\infty}\left(\sum_i \vec{E}_i\right)\cdot d\vec{l} = \sum_i\int_r^{\infty}\vec{E}_i\cdot d\vec{r} = \sum_i U_i(r)$$

1.28 N个点荷在$\vec{r}$处产生的总电势

$$U(\vec{r}) = \sum_i^N U_i(\vec{r}) = \frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{N}\frac{q_i}{|\vec{r}-\vec{r}_i|}$$

1.29 连续分布的带电体产生的电势

$$U(\vec{r}) = \int\frac{dq}{4\pi\varepsilon_0|\vec{r}-\vec{r}'|} = \frac{1}{4\pi\varepsilon_0}\iiint_V\frac{\rho(\vec{r}')dV'}{|\vec{r}-\vec{r}'|}$$

$\vec{E}\cdot\Delta\vec{l} = -\Delta U$

$\Delta U = -E_l\Delta l$

$E_l = -\frac{\Delta U}{\Delta l}$

$\nabla U = \frac{\partial U}{\partial n}\vec{n}$

1.30 电势与电场的关系 $\vec{E} = -\nabla U = -\frac{\partial U}{\partial n}\vec{n}$

1.31 直角坐标系中电势与电场的关系 $\vec{E} = E_x\vec{e}_x + E_y\vec{e}_y + E_z\vec{e}_z = -\frac{\partial U}{\partial x}\vec{e}_x - \frac{\partial U}{\partial y}\vec{e}_y - \frac{\partial U}{\partial z}\vec{e}_z$

$m\frac{d^2\vec{r}(t)}{dt^2} = q\vec{E}(r)$

$x = \frac{qE}{2m}t^2$

$\frac{1}{2}mv_1^2 + qU_1 = \frac{1}{2}mv_2^2 + qU_2$

$$x = \frac{qE}{2m} t^2$$

$$\frac{1}{2} m v_1^2 + qU_1 = \frac{1}{2} m v_2^2 + qU_2$$

$$v_2 = \sqrt{v_1^2 + \frac{2q(U_1 - U_2)}{m}}$$