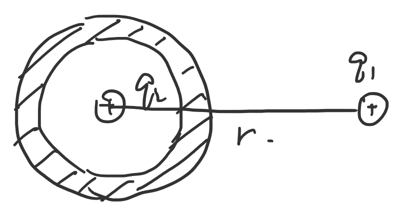
补充题

2022年3月17日 星期四　　上午9:57

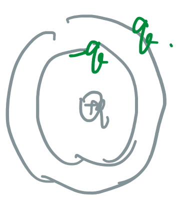
导体

1.


q_1 作用在 q_2 上的力.
q_2 受的力.

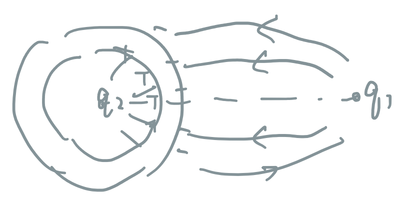
q_2 在腔内不受力. q_1 作用在 q_2 上 $F_c = k\frac{q_1q_2}{r^2}$
q_1 受 $F_c = \frac{q_1q_2}{4\pi\varepsilon_0 r^2}$.

外壳作用在 q_2 上.



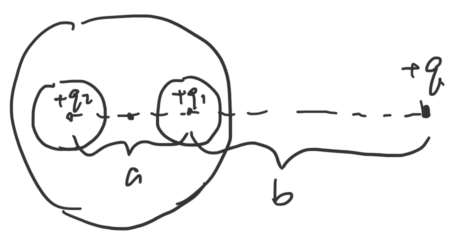
受电荷的力
受感应导体的力

内表面 $-q_2$ → F对称为0.
外表面.

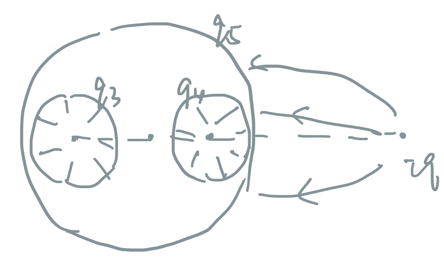


q_1 作用在 q_2.
$F_{21} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$.

q_2 受到的力来自 q_1 与导体壳. 内 q_3 外 q_4. $q_3 = -q_4$.
被球壳静电屏蔽 所以受力为0 ✓
内表面 $q_3 = -q_2$ (Gauss), 对称性使 q_2 受力 $F_{23} = 0$
外表面 q_4 来源于 { q_1 感应 → 与 q_1 的力抵消. / q_2 感应 → 对称均匀, $F=0$ }

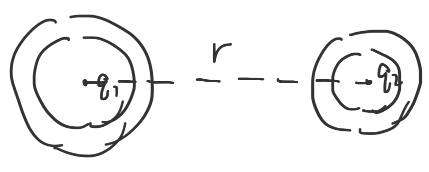
2.


球上电荷之代数和为0

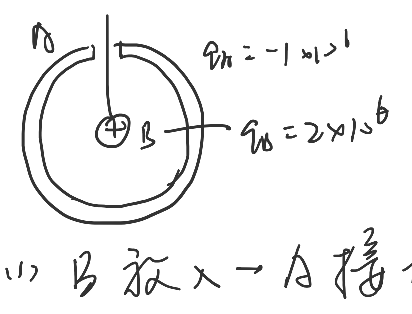


受电荷 $F_{11} = \frac{q_1 q}{4\pi\varepsilon_0(a+b)^2}$
$F_{12} = \frac{q_1q_2}{4\pi\varepsilon_0 a^2}$.

受感应 F_{13} 对称为0, $q_3 = -q_2$.
$F_{14} = \frac{q_4q_1}{4\pi\varepsilon_0 a^2}$, $q_4 = -q_1$.
$q_5 = q_3 + q_4 + q'$ $F_{15} = \frac{q_1 q'}{4\pi\varepsilon_0(a+b)^2}$, $q' = -q$.
均匀分布. 作用力为零.
$F_{14} = -F_{12}$, $F_{15} = -F_{11}$. 其他为零.
受合后球 $F_{14} + F_{13} + F_{15} =$ —.

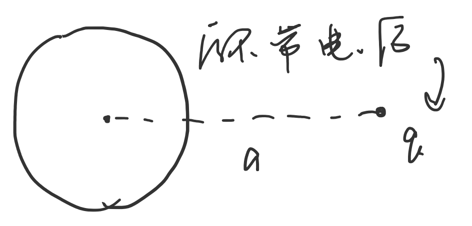
3.


q_1 作用在 q_2 上.
$F_{21} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$.
无加速度. 受合力为零.
去掉球壳有的距

13


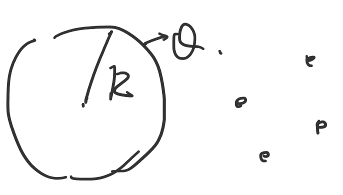
(1) B放入 → A接地 → A断开接地 → B取出.
(2) B接触A, B取出.

(1) B放入. A感应 $q' = -2\times10^{-6}$. $q_A = -2\times10^{-6}C$ 外表面上.
接地后仍都保持.
断开接地, B仍在里面, $q' = -2\times10^{-6}$.
(2) 接触中和. 都带 ~~2~~ $\times10^{-6}$.
$q_A = 1\times10^{-6}C$, 外表面.
$q_B = 0$.

14.


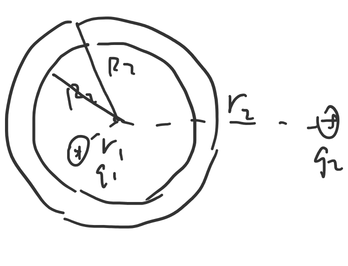
不带电导 求球的电势.

是个等势体 所以求球心处的电势.
$U_q = \int_a^\infty \frac{1}{4\pi\varepsilon_0}\times\frac{q}{r^2}dr = \frac{q}{4\pi\varepsilon_0}\int_a^\infty \frac{1}{r^2}dr$
$= -\frac{q}{4\pi\varepsilon_0}(\frac{1}{r}\Big|_a^\infty) = \frac{q}{4\pi\varepsilon_0 a}$.
感应电荷 q' 对球电势也有影响.
$U_{q'} = \int_R^\infty \frac{1}{4\pi\varepsilon_0}\frac{q'}{r^2}dr = \frac{q'}{4\pi\varepsilon_0 R}$ ✗
$U_{q'} = \frac{1}{4\pi\varepsilon_0}\int\frac{dq'}{R} = \frac{1}{4\pi\varepsilon_0 R}\int_q dq'$.
均匀分布, $\int_q dq'$ (正负抵消) $=0$.
$\therefore U_{q'} = 0$, $U = U_q$.

15.


$q_1 \cdots q_n$ $r_1 \cdots r_n$ 求电势.

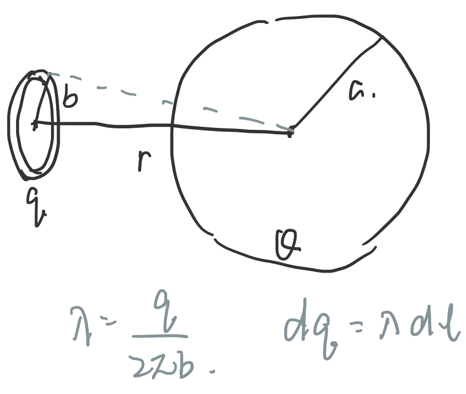
球外电荷. $\sum_{j=1}^{n}\frac{q_j}{4\pi\varepsilon_0 r_j}$.
感应电荷. 贡献0.
球面电荷 $U_Q = \frac{Q}{4\pi\varepsilon_0 R}$.
$\therefore U = U_q + U_{q'} + U_Q =$

17.


球壳带电量Q.
球心O的电势.

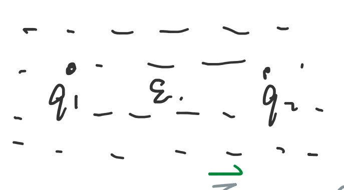
$U = U_{q_1} + U_{q_2} + U_{q_1'} + U_{q_2'}$.
$= \frac{q_1}{4\pi\varepsilon_0 r_1} + \frac{q_2}{4\pi\varepsilon_0 r_2} + \frac{q_{内}}{4\pi\varepsilon_0 R_1} + \frac{q_{外}}{4\pi\varepsilon_0 R_2}$

$q_{内} = q_1$ (Gauss)
$q_{外} = q_1 + Q + q_2$ $= q_1 + Q$.

18.


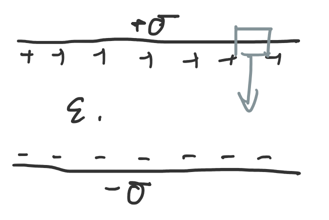
$\lambda = \frac{q}{2\pi b}$. $dq = \lambda dl$. $dE = \frac{dq}{4\pi\varepsilon_0(b^2+r^2)} = \frac{\lambda dl}{4\pi\varepsilon_0(b^2+r^2)}$
$E = \frac{q}{4\pi\varepsilon_0(r^2+b^2)}$. $U = \int_r^\infty \frac{q}{4\pi\varepsilon_0}\cdot\frac{1}{r^2+b^2}dr = \frac{q}{4\pi\varepsilon_0\sqrt{r^2+b^2}}$.

电介质

1.


q_1 对 q_2: $\vec{F}_{21} = \frac{q_1q_2}{4\pi\varepsilon_0 r^2}\hat{r}_{12}$
q_2 受介质 & q_1. $\oint_S \vec{D}\cdot d\vec{S} = D\times4\pi r^2 = q_1$.
q_2 处, $\vec{D} = \frac{q_1}{4\pi r^2}\hat{r}_{12}$, $\vec{E} = \frac{\vec{D}}{\varepsilon}$.
$\vec{F} = \frac{q_1q_2}{4\pi r^2\varepsilon}\hat{r}_{12}$. 不是均匀极化
$\therefore F = \frac{q_1q_2}{4\pi r^2}(\frac{1}{\varepsilon_0}+\frac{1}{\varepsilon})$ ~~$\hat{r}$~~ ✗

$F = \frac{q_1q_2}{4\pi r^2\varepsilon}\hat{r}$.
$q_1' = (\frac{\varepsilon_0}{\varepsilon}-1)q_1 = \frac{\varepsilon_0-\varepsilon}{\varepsilon}q_1$

3.


$\sigma S = DS$. $\vec{D} = -\sigma\hat{z}$
$\vec{E} = \frac{\vec{D}}{\varepsilon} = \frac{\sigma}{\varepsilon}(-\hat{z})$
$\vec{P} = D - \varepsilon_0\vec{E}$