

数学作业纸

科目 大物

华鑫纸品
Huaxin ZhiPin

班级：

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2-18. ∵ 铜球上下表面等势

$$\therefore \frac{Q_1}{C_1} = \frac{Q_2}{C_2}$$

$$\therefore C_1 = 4\pi\epsilon_{r1}\epsilon_0 R \quad C_2 = 4\pi\epsilon_{r2}\epsilon_0 R$$

$$\therefore Q_1 + Q_2 = Q$$

$$\therefore Q_1 = \frac{\epsilon_{r1}}{\epsilon_{r1} + \epsilon_{r2}} Q \quad Q_2 = \frac{\epsilon_{r2}}{\epsilon_{r1} + \epsilon_{r2}} Q$$

$$\therefore E_1 = \frac{\sigma_1}{\epsilon_{r1}\epsilon_0} = \frac{Q}{2\pi R^2 (\epsilon_{r1} + \epsilon_{r2})\epsilon_0} \quad \cancel{E_2 = \frac{Q}{2\pi R^2 (\epsilon_{r1} + \epsilon_{r2})\epsilon_0}} \\ = E_2$$

$$\therefore \sigma_1' = \frac{E_1}{\chi\epsilon_0} \quad P_1 = \frac{E_1}{\chi\epsilon_0} = \chi\epsilon_0 E = \frac{(\epsilon_{r1}-1)Q}{2\pi R^2 (\epsilon_{r1} + \epsilon_{r2})}$$

$$\sigma_1' = \vec{P}_1 \cdot \vec{n} = -\frac{(\epsilon_{r1}-1)Q}{2\pi R^2 (\epsilon_{r1} + \epsilon_{r2})}$$

$$\sigma_2' = -\frac{(\epsilon_{r2}-1)Q}{2\pi R^2 (\epsilon_{r1} + \epsilon_{r2})}$$

2-21. 取圆柱形高斯面

$$\oint_S D dS = \cancel{Q} \rightarrow \lambda L$$

$$D_1 = \frac{\lambda}{2\pi r}$$

$$\therefore E_1 = \frac{\lambda}{2\pi r \epsilon_1 \epsilon_0}$$

$$\therefore E_{1\max} = \frac{\lambda}{2\pi R_1 \epsilon_1}$$

$$\text{同理 } E_{2\max} = \frac{\lambda}{2\pi R_2 \epsilon_2}$$

$$\text{即有 } R_1 \epsilon_1 = R_2 \epsilon_2$$

$$\therefore U = \int_{R_1}^{R_2} E_1 dr + \int_{R_2}^{R_3} E_2 dr = \frac{\lambda}{2\pi \epsilon_1} \ln \frac{R_2}{R_1} + \cancel{\frac{\lambda}{2\pi \epsilon_2} \ln \frac{R_3}{R_2}}$$

$$\therefore C = \frac{Q}{U} = \frac{\lambda L}{\frac{\lambda}{2\pi \epsilon_1} \ln \frac{R_2}{R_1} + \frac{\lambda}{2\pi \epsilon_2} \ln \frac{R_3}{R_2}} = \frac{2\pi \epsilon_1 \epsilon_2 L}{\epsilon_2 \ln \frac{R_2}{R_1} + \epsilon_1 \ln \frac{R_3}{R_2}}$$

$$C_{\text{单位}} = \frac{2\pi \epsilon_1 \epsilon_2}{\epsilon_2 \ln \frac{R_2}{R_1} + \epsilon_1 \ln \frac{R_3}{R_2}}$$



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2-23. 设 A、B 带 $Q, -Q$.

$$\therefore E_{AK} = E_{BK} = \frac{Q}{\epsilon_0 S}$$

$$\therefore C_{AK} = C_{BK} = E_{d1} = \frac{Qd_1}{\epsilon_0 S} \quad \therefore C_{AK} = C_{BK} = \frac{\epsilon_0 S}{d_1}$$

$$\therefore \frac{1}{C_1} = \frac{1}{C_{AK}} + \frac{1}{C_{BK}} = \frac{2\epsilon_0 S}{Qd_1} \quad C_1 = \frac{C_{AK}C_{BK}}{C_{AK} + C_{BK}} = \frac{Qd_1}{2\epsilon_0 S} \frac{\epsilon_0 S}{2d_1}$$

$$\therefore F_{AB} = \frac{2Q}{\epsilon_0 S}$$

$$\therefore \frac{C_2}{U} = \frac{2Qd_2}{\epsilon_0 S} \quad C_2 = \frac{\epsilon_0 S}{Ud_2}$$

$$\therefore C = C_1 + C_2 = \frac{*Qd_1 + 4Qd_2}{2\epsilon_0 S}$$

$$\therefore C = C_1 + C_2 = \frac{\epsilon_0 S(d_1 + d_2)}{2d_1 d_2} = 7.12 \times 10^{-10} F$$

$$C' = C_{AK} + C_2 = 1.07 \times 10^{-9} F$$

2-24. 将 ~~带电极的平行板电容器串联~~ 并联平板电容.

$$C_0 = \frac{\epsilon_0 S}{d} = \frac{\epsilon_0 ab}{d}$$

$$\therefore dC = \frac{r \tan \theta - Q}{(d+r \tan \theta) \frac{Q}{\epsilon_0 ab dr}} dr = \frac{\epsilon_0 b}{d+r} \cdot \frac{1}{a} dr = \frac{\epsilon_0 ab}{rl} dr$$

$$\therefore C' = \int_0^a \frac{\epsilon_0 ab}{rl} dr =$$

$$\frac{1}{C'} = \int_0^a \frac{\epsilon_0 b}{\epsilon_0 ab} dr \Rightarrow C = \int_0^a \frac{\epsilon_0 b}{d + \frac{b}{a} r} dr = \frac{\epsilon_0 ba}{l} \ln \left(d + \frac{b}{a} r \right) \Big|_0^a$$

$$= \frac{\epsilon_0 ba}{l} \ln \left(\frac{d+b}{d} \right)$$



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2-27. 设上板带 $+Q$. 则下板带 $-Q$

$$\text{则 } E_1 = \frac{\sigma}{\epsilon_r \epsilon_0} = \frac{Q}{S \epsilon_r \epsilon_0}$$

$$E_2 = \frac{Q}{S \epsilon_r \epsilon_0}$$

$$\therefore U = E_1 \frac{d}{2} + E_2 \frac{d}{2} = \frac{Qd}{2S\epsilon_0} \left(\frac{1}{\epsilon_{r1}} + \frac{1}{\epsilon_{r2}} \right) = \frac{Qd(\epsilon_{r1} + \epsilon_{r2})}{2S\epsilon_0 \epsilon_{r1} \epsilon_{r2}}$$

$$\therefore C = \frac{Q}{U} = \frac{2S\epsilon_0 \epsilon_{r1} \epsilon_{r2}}{d(\epsilon_{r1} + \epsilon_{r2})}$$

2-29. 设上半部分带电 Q_1 . 下半带 Q_2 . 则求总电荷 $Q_1 + Q_2$

$$\text{则 } D_1 = \frac{Q_1}{2\pi r^2} \quad E_1 = \frac{Q_1}{2\pi r^2 \epsilon_0}$$

$$E_2 = \frac{Q_2}{2\pi r^2 \epsilon_0 \epsilon_r}$$

$$\therefore U = E_1 d = E_2 d \quad \text{即 } Q_1 = \frac{Q_2}{\epsilon_r}$$

$$\because Q_1 + Q_2 = Q \quad U = \int_{R_1}^{R_2} E_1 dr = \frac{R_2}{2\pi \epsilon_0 (R_1 - R_2) \epsilon_0} \frac{(R_2 - R_1) Q}{2\pi R_1 R_2 \epsilon_0}$$

$$\therefore C = \frac{Q}{U} = \frac{Q_1 + Q_2}{2\pi r^2 \epsilon_0} \quad \frac{Q_1 + Q_2}{Q_1(R_2 - R_1)} = \frac{(\epsilon_r + 1) Q_1}{Q_1(R_2 - R_1)}$$

$$= \frac{2\pi r^2 \epsilon_0 (\epsilon_r + 1) R_1 R_2}{R_2 - R_1}$$

2-31. 设第二个电容 C'

$$\therefore C = C_1 + C'$$

$$\therefore Q_0 = C_1 U_0 = (C_1 + C') U'$$

$$\therefore C' = \frac{C_1 U_0}{U'} - C_1 = \frac{700}{3} \text{ pF} \approx 233 \text{ pF}$$

$$\Delta W = \frac{1}{2} C_1 U_0^2 - \frac{1}{2} C U'^2 = 3.5 \times 10^{-7} \text{ J}$$

电能转化为电荷从原电容转移至另一个电容时产生的热能



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$$2-35-(1) \because E = \frac{Q}{S} \cdot \frac{1}{\epsilon_0}$$

$$U_0 = Ed = \frac{Qd}{\epsilon_0 S} \quad U' = E(d-b) = \frac{Q(d-b)}{\epsilon_0 S}$$

$$\therefore \Delta A = \frac{1}{2} Q(U' - U_0) = -\frac{Qb}{2\epsilon_0 S}$$

(2) $\because \Delta A < 0$. 故系统对外做功

$$\therefore \text{导体板能量增大} \quad W = \Delta A = -\frac{Qb}{2\epsilon_0 S}$$

被吸入

$$(3) \because \frac{Qd}{\epsilon_0 S} = \frac{Q'd(d-b)}{\epsilon_0 S}$$

$$Q' = \frac{d}{d-b} Q_0$$

$$\therefore \Delta A = \frac{1}{2} U(Q' - Q_0) = \frac{1}{2} U \cdot \frac{b}{d-b} Q_0 = \frac{1}{2} U \cdot \frac{b}{d-b} \cdot \frac{U \epsilon_0 S}{d} = \frac{b \epsilon_0 S U^2}{2d(d-b)}$$

\therefore 导体板进入时、电源做功 $W_{\text{源}} = U \Delta Q = 2\Delta A$

$$\therefore \text{外力做功 } \Delta A' = \Delta A - W_{\text{源}} = -\frac{b \epsilon_0 S U^2}{2d(d-b)}$$

$$W = \Delta A' = -\frac{b \epsilon_0 S U^2}{2d(d-b)} \quad \text{被吸入}$$

$$W = \Delta A' = -\frac{b \epsilon_0 S U^2}{2d(d-b)} \quad \text{被吸入}$$

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