参考答案

一、选择题

题号	1	2	3	4	5
答案	D	С	В	A	С

二、填空题

- 1. $5 \mu F$; $20 \mu F$
- 2. 11/6; 11/6
- 3. $\ln 3 / \ln 2$; $\ln 2 / \ln 3$
- 4. 减小; ε,

5.
$$\frac{Q^2}{16\pi\varepsilon_0 R}$$

三、计算题

1. 设 A、B 两极板分别带电 Q 和-Q,利用电介质中的高斯定理 $\oint \overrightarrow{D} \cdot d\overrightarrow{S} = \sum q$ 得球壳内 的电位移矢量 \overline{D} 为

$$\overrightarrow{D} = \frac{Q}{4\pi r^3} \overrightarrow{r} \qquad (R_{\rm A} < r < R_{\rm B})$$

$$\overrightarrow{D} = \frac{Q}{4\pi r^3} \overrightarrow{r}$$
 $(R_A < r < R_B)$ 由此得
$$\overrightarrow{E}_1 = \frac{Q}{4\pi \varepsilon_0 \varepsilon_1 r^3} \overrightarrow{r}$$
 $(R_A < r < R_C)$

$$\overline{E}_2 = \frac{Q}{4\pi\varepsilon_0\varepsilon_2r^3}\overline{r} \qquad (R_{\rm C} < r < R_{\rm B})$$

此时 A、B 两极板间的电势差 $U_{\scriptscriptstyle{\mathsf{AR}}}$ 为

$$U_{AB} = \int_{R_A}^{R_C} \overrightarrow{E}_1 \cdot d\overrightarrow{r} + \int_{R_C}^{R_B} \overrightarrow{E}_2 \cdot d\overrightarrow{r} = \int_{R_A}^{R_C} \frac{Q}{4\pi\varepsilon_0\varepsilon_1 r^2} dr + \int_{R_C}^{R_B} \frac{Q}{4\pi\varepsilon_0\varepsilon_2 r^2} dr$$

$$= \frac{Q}{4\pi\varepsilon_0\varepsilon_1} \left(\frac{1}{R_A} - \frac{1}{R_C}\right) + \frac{Q}{4\pi\varepsilon_0\varepsilon_2} \left(\frac{1}{R_C} - \frac{1}{R_B}\right) = \frac{Q}{24\pi\varepsilon_0R_A} \left(\frac{2}{\varepsilon_1} + \frac{1}{\varepsilon_2}\right)$$

$$C = \frac{Q}{U_{\text{AB}}} = \frac{24\pi\varepsilon_0 R_{\text{A}}}{\left(\frac{2}{\varepsilon_1} + \frac{1}{\varepsilon_2}\right)} = \frac{24\pi\varepsilon_0 \varepsilon_1 \varepsilon_2 R_{\text{A}}}{2\varepsilon_2 + \varepsilon_1}$$

2. 先利用利用电介质中的高斯定理 $\oint \overrightarrow{D} \cdot d\overrightarrow{S} = \sum q$ 得球壳内的电位移矢量 \overrightarrow{D}

$$\overline{D} = \frac{q}{4\pi r^2} \overline{r_0} \qquad (R_{\rm A} < r < R_{\rm B})$$

$$\overline{E}_1 = \frac{Q}{4\pi\varepsilon_0\varepsilon_1 r^2} \overline{r_0} \qquad (R_A < r < R_C)$$

$$\vec{E}_2 = \frac{Q}{4\pi\varepsilon_0 r^2} \vec{r_0} \qquad (R_{\rm C} < r < R_{\rm B})$$

$$dW_{\rm e} = \frac{1}{2}DEdV = \frac{1}{2}DE4\pi r^2 dr$$

$$W_{\rm e} = \int_{V} dW = \int_{R_{\rm A}}^{R_{\rm C}} \frac{1}{2} \frac{q}{4\pi r^{2}} \frac{q}{4\pi \varepsilon_{0} \varepsilon_{1} r^{2}} 4\pi r^{2} dr + \int_{R_{\rm C}}^{R_{\rm B}} \frac{1}{2} \frac{q}{4\pi r^{2}} \frac{q}{4\pi \varepsilon_{0} r^{2}} 4\pi r^{2} dr$$

$$= \frac{q^2}{8\pi\varepsilon_0\varepsilon_1} \left(\frac{1}{R_{\rm A}} + \frac{\varepsilon_1 - 1}{R_{\rm C}} - \frac{\varepsilon_1}{R_{\rm B}} \right)$$