第二节 电通量 高斯定律

1、C；2、A；3、B；4、$\pi R^2 E$

5、解：以 o 为球心，r 为半径作一同心球面作为高斯面，

$r < R_1, \Phi = \oint \vec{E} \bullet d\vec{S} = \oint E \bullet dS = 0, E = 0$

$R_1 < r < R_2, \Phi = \oint \vec{E} \bullet d\vec{S} = \oint E \bullet dS = E \bullet 4\pi r^2 = \dfrac{Q_1}{\varepsilon_0}, E = \dfrac{Q_1}{4\pi\varepsilon_0 r^2}$

$r > R_2, \Phi = \oint \vec{E} \bullet d\vec{S} = \oint E \bullet dS = E \bullet 4\pi r^2 = \dfrac{Q_1 + Q_2}{\varepsilon_0}, E = \dfrac{Q_1 + Q_2}{4\pi\varepsilon_0 r^2}$

6、解：以轴为中心，以 r 为半径，作高为 l 的同心圆柱面作为高斯面。

由高斯定理$\Phi = \oint \vec{E} \bullet d\vec{S} = \dfrac{Q_{in}}{\varepsilon_0}$得$\Phi = \oint \vec{E} \bullet d\vec{S} = 2\pi r l E = \dfrac{Q_{in}}{\varepsilon_0}$

当$r > R_2$时$, Q_{in} = \left(\lambda_1 + \lambda_2\right) l, E = \dfrac{\lambda_1 + \lambda_2}{2\pi\varepsilon_0 r}$

7、（1）取同心球面为高斯面，由高斯定理求 E

$$r \le R: \quad E \cdot 4\pi r^2 = \frac{1}{\varepsilon_0}\int \rho dV = \frac{1}{\varepsilon_0}\int_0^r \frac{3Q}{\pi R^3}(1 - \frac{r'}{R}) 4\pi r'^2 \cdot dr'$$

$$E = \frac{\rho_0 r(4R - 3r)}{12\varepsilon_0 R} = \frac{Qr(4R - 3r)}{4\pi\varepsilon_0 R^4}$$

$$r > R: \quad E \cdot 4\pi r^2 = \frac{1}{\varepsilon_0}\int \rho dV = \frac{1}{\varepsilon_0}\int_0^R \frac{3Q}{\pi R^3}(1 - \frac{r'}{R}) 4\pi r'^2 \cdot dr'$$

$$E = \frac{\rho_0 R^3}{12\varepsilon_0 r^2} = \frac{Q}{4\pi\varepsilon_0 r^2}$$

（2）$\dfrac{dE}{dr} = 0 \Rightarrow \quad r = \dfrac{2}{3}R$时，$E = E_{\max} = \dfrac{\rho_0 R}{9\varepsilon_0} = \dfrac{Q}{3\pi\varepsilon_0 R^2}$

8、解：以 x 轴为轴线，r 为半径，作一个圆柱面作为高斯面，圆柱面的上下底面距离原点 0 距离为 x。

由高斯定理$\Phi = \oint \vec{E} \bullet d\vec{S} = \dfrac{Q_{in}}{\varepsilon_0}$得$\Phi = \oint \vec{E} \bullet d\vec{S} = 2\pi r^2 E = \dfrac{Q_{in}}{\varepsilon_0}$

当$|x|<\frac{d}{2}$时,$Q_{in}=\pi r^{2}\bullet 2x\rho, E=\frac{1}{2\pi r^{2}}\pi r^{2}\bullet 2x\rho=\frac{x\rho}{\varepsilon_{0}}$

当$|x|\geq\frac{d}{2}$时,$Q_{in}=\pi r^{2}\bullet d\rho, E=\frac{1}{2\pi r^{2}}\pi r^{2}d\rho=\frac{d\rho}{2\varepsilon_{0}}$