9.29. 14-22

$\oint E \cdot ds = \frac{Q}{\varepsilon_0 \varepsilon}$

$2\pi r l E = \frac{\sigma \cdot l}{\varepsilon_0 \varepsilon}$ $(\sigma = \lambda)$

$\therefore E = \frac{\sigma}{2\pi r \varepsilon_0 \varepsilon}$

$\int E dl = \int_a^b \frac{\sigma}{2\pi r \varepsilon_0 \varepsilon} dr$

$= \frac{\sigma}{2\pi \varepsilon_0 \varepsilon} \ln b/a$

$\therefore V = \frac{\lambda}{2\pi \varepsilon_0 \varepsilon} \ln b/a$

$\therefore W_e = \frac{1}{2} q V = \frac{\lambda^2}{4\pi \varepsilon_0 \varepsilon} \ln b/a$

14-23.

(1) $W_e = \frac{1}{2} q V$

$\oint D ds = Q$

$\therefore D \cdot 4\pi r^2 = Q$ ($r > R$ 时)

$D = \frac{Q}{4\pi r^2}$

又$\because$ $D = \varepsilon_0 \varepsilon E$

$\therefore E = \frac{Q}{4\pi \varepsilon_0 \varepsilon r^2}$

$V = \int E dl = \int_R^{+\infty} \frac{Q}{4\pi \varepsilon_0 \varepsilon r^2} dr$

$= \frac{Q}{4\pi \varepsilon_0 \varepsilon R}$

$\therefore W_e = \frac{1}{2} q V = \frac{Q^2}{8\pi \varepsilon_0 \varepsilon R}$

(2) $\frac{1}{2} W_e = \frac{Q^2}{16\pi \varepsilon_0 \varepsilon R}$

$\because$ 导体球不变 $\therefore E$ 不变

设半径为 x

$\frac{1}{2} Q \int_R^x \frac{Q}{4\pi \varepsilon_0 \varepsilon r^2} dr = \frac{Q^2}{16\pi \varepsilon_0 \varepsilon R}$

$\Rightarrow \frac{1}{R} - \frac{1}{x} = \frac{1}{2R}$

$\therefore x = 2R$

15-3
$$B=\frac{\mu_0}{4\pi}\frac{q(\vec{v}\times\hat{r})}{r^2}$$
$$=\frac{\mu_0 \cdot q \cdot v}{4\pi}\cdot\frac{1}{r^2}$$
$$\Rightarrow dB=\frac{\mu_0 v}{4\pi}\cdot\frac{dq}{r^2}$$
$$B=\int dB=\frac{\mu_0 v}{4\pi}\cdot\int_0^l \frac{1}{(a+x)^2}dx\cdot q/l$$
$$(dq = q/l\cdot dl)$$

$$\therefore B=\frac{\mu_0 v q}{4\pi l}\cdot\left(\frac{1}{a}-\frac{1}{a+l}\right)$$
代入数据

$$\therefore B=5\times10^{-10}\ T$$
方向垂直纸面向里.

15-4
$$dI = I/\pi R$$

对于一细长部分可得.
$$dB=\frac{\mu_0\cdot dI}{2\pi R}$$
$$B=\int dB=\int_0^{\pi}\frac{\mu_0\cdot I}{2\pi R\cdot\pi R}\cdot R\cdot\sin\theta d\theta$$

$$=\frac{\mu_0 I}{\pi^2 R}=6.37\times10^{-5}\ T$$
方向向x轴正方向

15-5 (a) 上半圆.
$$dB=\frac{\mu_0 I\cdot dl\cdot\sin\theta}{4\pi\cdot r^2}$$
$$B=\frac{\mu_0 I}{4\pi r^2}\cdot\int dl$$
$$=\frac{\mu_0 I}{4\pi r^2}\cdot\pi r$$
$$=\frac{\mu_0 I}{4r}$$
$$\therefore B=\frac{\mu_0 I}{4R_1}$$
下半圆同理
$$\therefore B_1=\frac{\mu_0 I}{4R_1}+\frac{\mu_0 I}{4R_2}$$
方向垂直纸面向里

(b) 由 (a) 易得
$$B_2'=\frac{3\mu_0 I}{8R}.$$
对于下侧直线，同样会产生磁场
$$B_2''=\frac{\mu_0 I}{4\pi R}(\cos\theta_1-\cos\theta_2)$$
$$=\frac{\mu_0 I}{4\pi R}$$
$$\therefore B_2=\frac{3\mu_0 I}{8R}+\frac{\mu_0 I}{4\pi R}$$
方向垂直于纸面向里.

(C) 由(C)得.对于135°角

$$B_3' = \frac{\mu_0 I}{4\pi R^2} \cdot \frac{3}{4}\pi R$$

$$= \frac{3\mu_0 I}{16R}$$

∵ 对称性.上下方电流对O点产生磁场效果等价.

$$\therefore B_3'' = \frac{\mu_0 I}{4\pi R} \cdot (\cos\theta_1 - \cos\theta_2) \cdot 2$$

$$= \frac{\mu_0 I}{2\pi R}$$

$$\therefore B_3 = \frac{3\mu_0 I}{16R} + \frac{\mu_0 I}{2\pi R}$$

方向垂直纸面向外.

15-8 设导线于圆心处呈夹角θ

$$\overset{\frown}{AB_1} = \frac{\theta}{360}R$$

$$\overset{\frown}{AB_2} = \frac{360-\theta}{360}R$$

$$\therefore R_{AB_1}/R_{AB_2} = \frac{\theta}{360-\theta}$$

$$\therefore I_{AB_1}/I_{AB_2} = \frac{360-\theta}{\theta}$$

$$B_1' = \frac{\mu_0 I}{4\pi R^2} \cdot \frac{\theta}{360} \cdot 2\pi \cdot R$$

$$= \frac{\mu_0 I_1}{2R} \cdot \frac{\theta}{360}$$

$$B_2' = \frac{\mu_0 I}{4\pi R^2} \cdot \frac{360-\theta}{360} \cdot 2\pi \cdot R$$

$$= \frac{\mu_0 I_2}{2R} \cdot \frac{360-\theta}{360}$$

$$\because I_1/I_2 = \frac{360-\theta}{\theta}$$

$$\therefore B_1'/B_2' = 1$$

∴ B_1' 垂直纸面向里

B_2' 垂直于纸面向外

$$\therefore B_0 = 0\,T$$

15-9 (1) $B = \frac{\mu_0 I}{4\pi R} \cdot (\cos\theta_1 - \cos\theta_2) = \frac{\mu_0 I}{2\pi R}$

$$\therefore B = 7.2\times10^{-5}\,T$$

(2) ∵ $B_{地} = 6\times10^{-5}\,T$

$$\therefore B/B_{地} = \frac{7.2\times10^{-5}\,T}{6\times10^{-5}\,T} = 1.2$$