4-14. 设导线上电流大小为 I.
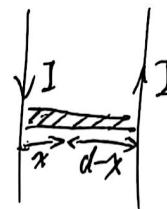
$\because B = \dfrac{\mu_0 I}{2\pi r}$

$\therefore \Phi = \int_S B\,dS = \int_0^d \left(\dfrac{\mu_0 I l}{2\pi x} + \dfrac{\mu_0 I l}{2\pi (d-x)} \right) dx$

$\qquad = \dfrac{\mu_0 I l}{\pi} \ln \dfrac{d-a}{a}$

$\therefore L = \dfrac{\Phi}{I l} = \dfrac{\mu_0}{\pi} \ln \dfrac{d-a}{a}$

4-15. $\because \varepsilon = -L \dfrac{dI}{dt}$

$\qquad L = \dfrac{\varepsilon}{\frac{dI}{dt}} = 0.8 mH$

$\because B = \dfrac{\mu_0 N I}{l} = \mu_0 I$ (crossed out)

$\dfrac{\Phi}{} = \dfrac{}{}$ (crossed out) $\quad \therefore L = N \dfrac{\Phi}{I}$

$\qquad\qquad N = \dfrac{LI}{\Phi} = 400$

4-17. $\because$ 设导线上电流为 I

$\therefore B = \dfrac{\mu_0 N I}{2\pi r}$ (crossed out) $\dfrac{\mu_0 I}{2\pi r}$

$\therefore \Phi = \int B\,dS = \int_{R_1}^{R_2} N \cdot \dfrac{\mu_0 I}{2\pi r} \cdot h\,dr = N \dfrac{\mu_0 I h}{2\pi} \ln \dfrac{R_2}{R_1}$

$\therefore M = \dfrac{\Phi}{I} = \dfrac{N \mu_0 h}{2\pi} \ln \dfrac{R_2}{R_1}$

4-18. 设大线圈中有 I.

$\therefore B = \dfrac{\mu_0}{2} \cdot \dfrac{I R^2}{(R^2 + d^2)^{\frac{3}{2}}}$

$\therefore \Phi = NBS = \dfrac{N N_1 \mu_0 I R^2 \cdot \pi r^2}{2(R^2 + d^2)^{\frac{3}{2}}}$

$\therefore M = \dfrac{\Phi}{I} = \dfrac{N_1 N_2 \mu_0 R^2 \pi r^2}{2(R^2 + d^2)^{\frac{3}{2}}}$

$\because \Phi_{12} = M I_2$

$\dfrac{d\Phi_{12}}{dt} = M \dfrac{dI_2}{dt} = \dfrac{N_1 N_2 \mu_0 R^2 \pi r^2}{2(R^2 + d^2)^{\frac{3}{2}}} \cdot k.$

4-20. 设半径为R

$\therefore \lambda = \dfrac{I}{\pi R^2}$

$\therefore B = \dfrac{\mu_0 \lambda \cdot \pi r^2}{2\pi r} = \dfrac{\mu_0 I r}{2\pi R^2}$

$\therefore W_m = \int_V \dfrac{B^2}{2\mu_0} dV = \int_0^R \left(\dfrac{\mu_0 I r}{2\pi R^2}\right)^2 / 2\mu_0 \cdot l \cdot 2\pi r \, dr = \int_0^R \dfrac{\mu_0 I^2 r^3 l}{4\pi R^4} dr = \dfrac{\mu_0 I^2 l}{16\pi}$
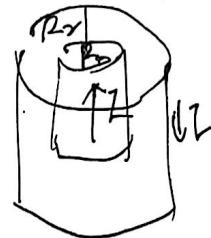
$\therefore$ 单位长度 $W = \dfrac{\mu_0 I}{16\pi}$

4-21. 由 $\oint_L H dl = I_A$

$\therefore H = \begin{cases} \dfrac{Ir}{2\pi R_1^2}, & r < R_1 \\[2mm] \dfrac{I}{2\pi r}, & R_1 < r < R_2 \\[2mm] 0, & r > R_2 \end{cases}$

$\therefore dW_m = w_m dV = \dfrac{1}{2}\mu H^2 \cdot 2\pi r l\, dr = \mu \pi H^2 l r\, dr$

$\therefore W_m = \int_0^{R_1} \dfrac{\mu_0 I^2 r^3 l}{4\pi R_1^4}\, dr + \int_{R_1}^{R_2} \dfrac{\mu_0 I^2 l}{4\pi r}\, dr = \dfrac{\mu_0 I^2 l}{16\pi} + \dfrac{\mu_0 I^2 l}{4\pi}\ln\dfrac{R_2}{R_1}$

$\therefore$ 单位长度 $W = \dfrac{\mu_0 I^2}{16\pi}\left(1 + 4\ln\dfrac{R_2}{R_1}\right)$

4-22. (1) $\because D = \varepsilon_0 E$

$\therefore I_d = \dfrac{\partial}{\partial t}\oint_S D dS = \dfrac{\partial}{\partial t}\left(\varepsilon_0 E_0 \cos\omega t \cdot \pi R^2\right)$

$= -\varepsilon_0 \pi \omega R^2 E_0 \sin\omega t$

(2) $\because \oint_L H d l = \oint_S \dfrac{\partial D}{\partial t} dS$ $\oint_L I d l = \mu \pi I_d$

当 $r < R$. $H \cdot 2\pi r = \mu_2 I_d \cdot \dfrac{\pi r^2}{\pi R^2}$

$H = \dfrac{I_d r}{2} = -\dfrac{\varepsilon_0 \pi \omega R^2 E_0 \sin\omega t}{2}$

$B = \mu_0 H = -\dfrac{\varepsilon_0 \mu_0 \pi r \omega R^2 E_0 \sin\omega t}{2} = -\dfrac{\varepsilon_0 \mu_0 \omega r}{2}E_0 \sin\omega t$

当 $r > R$ $B = \dfrac{\mu_0 I_d}{2\pi r} = -\dfrac{\varepsilon_0 \mu_0 \pi \omega R^2 E_0 \sin\omega t}{2r}$

即 $B = \begin{cases} -\dfrac{\varepsilon_0 \mu_0 \omega r E_0 \sin\omega t}{2}, & r < R. \\[3mm] -\dfrac{\varepsilon_0 \mu_0 \omega R^2 E_0 \sin\omega t}{2r}, & r > R. \end{cases}$

4-23.

$$\because \oint_S \vec{D} \, d\vec{S} = q_内$$

$$D = \frac{q_内}{S}$$

$$\therefore I_d = -\oint_S \frac{\partial \vec{D}}{\partial t} d\vec{S} = -\frac{\partial \vec{D}}{\partial t} \cdot S = -\frac{\partial q_内}{\partial t}$$

$$\therefore q_内 = CU = 1\times10^{-12} \times 1.74\times10^5 \times \cos100\pi t \ C$$

$$= 0.174 \cos100\pi t \ \mu C$$

$$\therefore I_{dmax} = \overset{17.4}{\cancel{1740}} \sin100\pi t \, \mu A$$

$$I_{dmax} = \overset{17.4}{\cancel{1740}}\pi \, \mu A \approx 54.6 \, \mu A$$