习题答案

习 题 一

1.1　(1)　$2\hat{x}+6\hat{y}+10\hat{z}$　　(2)　$2\sqrt{35}$

　(3)　$-12\hat{y}$　　　　(4)　12

1.2　(-1，1，-1) 与 $\left(-\frac{1}{3},\ \frac{1}{9}\ ,\ -\frac{1}{27}\right)$。

1.5　(1)　$\vec{C}_A=-\frac{1}{\sqrt{5}}\hat{\rho}-\frac{3}{\sqrt{5}}\hat{\varphi}+2\hat{z}$　　　　$\vec{C}_B=-\sqrt{2}\hat{\varphi}+2\hat{z}$

　(2)　$\vec{C}_A=\frac{5}{\sqrt{14}}\hat{r}-\frac{13}{\sqrt{70}}\hat{\theta}-\frac{3}{\sqrt{5}}\hat{\varphi}$　　　$\vec{C}_B=\frac{2}{3}\hat{r}-\frac{4\sqrt{2}}{3}\hat{\theta}-\sqrt{2}\hat{\varphi}$

1.6　$\vec{F}=\hat{r}\left(\frac{{\rho_0}^2\sin\varphi_0}{\sqrt{{\rho_0}^2+{z_0}^2}}+\frac{z_0\cos\varphi_0}{\sqrt{{\rho_0}^2+{z_0}^2}}\right)+\hat{\theta}\left(\frac{z_0\rho_0\sin\varphi_0}{\sqrt{{\rho_0}^2+{z_0}^2}}-\frac{\rho_0\cos\varphi_0}{\sqrt{{\rho_0}^2+{z_0}^2}}\right)+\hat{\varphi}{\rho_0}^2$

1.7　(1)　$(-2\,,2\sqrt{3}\,,3)$　；　(2)　$(5\,,53.1^0\,,120^0)$

1.8　$|E|=0.5$　，　$\vec{E}=-\hat{x}0.212+\hat{y}0.2829-\hat{z}0.3536$ ，

　$E_x=-0.212$　，　$\angle\vec{E},\vec{B}=153.59^0$

1.9　$75\,\pi^2$

1.10　4.

1.11　在 $O(0,0,0)$ 与 $A(1,1,1,)$ 处梯度的模依次为 7 与 $3\sqrt{5}$；方向余弦依次为 $\frac{3}{7},\frac{-2}{7},\frac{-6}{7}$

　与 $\frac{2}{\sqrt{5}},\frac{1}{\sqrt{5}},0$；梯度为零的点是(-2,1,1).

1.13　(1)　$\vec{F}=\hat{\rho}2\rho\cos\varphi+\hat{\varphi}\frac{1}{\rho}(z^2\cos\varphi-\rho^2\sin\varphi)+\hat{z}2z\sin\varphi$

　(2)　$\vec{F}=\hat{r}(2ar-\frac{3}{r^4})\sin 2\theta\cos\varphi+\hat{\theta}2(ar+\frac{1}{r^4})\cos 2\theta\cos\varphi-\hat{\varphi}2(ar+\frac{1}{r^4})\cos\theta\sin\varphi$.

　(3)　$\vec{F}=\hat{r}\left(2\sin\theta+2r\cos\theta\right)+\hat{\theta}2\cos\theta-\hat{\varphi}\frac{r\sin\varphi}{\sin\theta}$.

1.14　$\Phi=2\pi a^3$.

1.15　(1)　6　；　(2)　8　.

1.16　$\nabla\cdot\vec{F}=0$　，　$(r\neq 0)$.

1.17　$\vec{r}(\rho,\varphi,z)=\hat{\rho}\rho+\hat{z}z$　，　$\vec{r}(r,\theta,\varphi)=\hat{r}r$.

1.18　(1)　$\frac{1}{r}\vec{r}\cdot\vec{a}$　；　(2)　$2\vec{r}\cdot\vec{a}$　；　(3)　$nr^{n-2}\vec{r}\cdot\vec{a}$　.

1.19　n=-3

1.21　$2\pi a^2$

1.22　$\frac{19}{3}$

1.23　(1)　$\nabla\cdot\vec{F}=(8x+3y)y$　；　　$\nabla\times\vec{F}=4xz\hat{x}+(1-2yz)\hat{y}-(z^2+3x^2)\hat{z}$

(2) $\nabla\cdot\vec{F}=2\cos^2\varphi+\cos\varphi$ ； $\nabla\times\vec{F}=(2\sin\varphi+\sin 2\varphi)\hat{z}$

(3) $\nabla\cdot\vec{F}=0$ ； $\nabla\times\vec{F}=x(2y-x)\hat{x}+y(2z-y)\hat{y}+z(2x-z)\hat{z}$

(4) $\nabla\cdot\vec{F}=P'(x)+Q'(y)+R'(z)$ ； $\nabla\times\vec{F}=0$

1.24 $\nabla\times(\vec{A}\times\vec{B})=4z(xz-4)\hat{y}+3x^2yz\hat{z}$.

1.25 (1) 0 ； (2) 0 ； (3) $\dfrac{1}{r}f'(r)[\vec{r}\times\vec{c}]$ ； (4) 0 .

1.27 (1) $\Phi=\cos z-\sin xy+c$ ； (2) $\Phi=-y^2\cos x-x^2\cos y+c$

1.28 (1) 7 ； (2) 73 .

1.31 $\Phi=-\left(x^2+2y^2+xy+2yz-3z^2\right)+c$

1.32 $\nabla^2u=6z+24xy-2z^3-6y^2z$

1.34 势函数 $\Phi=-r^2\sin\theta-\cos\varphi+c$

习 题 二

2.1 $\vec{F}_2=1.63\times10^{-28}(\hat{x}-\hat{y})$ N

2.2 51.2 N

2.3 $\vec{E}=\dfrac{Q}{4\pi\varepsilon_0}(-2\hat{x}+3\hat{y})$ V/m

2.4 6.64×10^5 个/cm^2

2.5 $\vec{E}=\hat{z}\dfrac{\rho_l az}{2\varepsilon_0(a^2+z^2)^{3/2}}$

2.6 (1) $E_z=\dfrac{mg}{e}=5.58\times10^{-11}$ V/m (2) $r=\sqrt{\dfrac{e^3}{4\pi\varepsilon_0 mg}}\approx2\times10^{-9}$ m

2.7 $W=2.376\times10^{-3}$ N·m

2.8 $U=\dfrac{\rho_s a}{2\varepsilon_0}\ln\dfrac{z+L+\sqrt{a^2+(z+L)^2}}{z-L+\sqrt{a^2+(z-L)^2}}$

$\vec{E}=\hat{z}\dfrac{\rho_s a}{2\varepsilon_0}\left[\dfrac{1}{\sqrt{a^2+(z-L)^2}}-\dfrac{1}{\sqrt{a^2+(z+L)^2}}\right]$

2.9 $\rho=\varepsilon_0(5r^2+4Ar)$ $(r\le a)$

2.10 $\rho=0$ $(r\ge a)$ ； $\rho=3\varepsilon_0$ $(r\le a)$

2.11 $U=\dfrac{Q+Q'}{4\pi\varepsilon_0 r}$ ， $\vec{E}=\hat{r}\dfrac{Q+Q'}{4\pi\varepsilon_0 r^2}$ $(r\ge c)$

$U=\dfrac{1}{4\pi\varepsilon_0}\left[Q\left(\dfrac{1}{r}-\dfrac{1}{b}+\dfrac{1}{c}\right)+\dfrac{Q'}{c}\right]$ $(a\le r\le b)$

$\vec{E}=\hat{r}\dfrac{Q}{4\pi\varepsilon_0 r^2}$ $(a\le r\le b)$

2.13 $U=-\dfrac{a^2r^2}{6\varepsilon_0}+\dfrac{r^4}{20\varepsilon_0}+\dfrac{a^4}{4\varepsilon_0}$ ， $\vec{E}=\hat{r}\dfrac{1}{\varepsilon_0}\left(\dfrac{a^2r}{3}-\dfrac{r^3}{5}\right)$ $(r\le a)$

$U=\dfrac{2a^5}{15\varepsilon_0 r}$, $\vec{E}=\hat{r}\dfrac{2a^5}{15\varepsilon_0 r^2}$ $(r\ge a)$

2.14 (1) 0 ; (2) $\sqrt{3}/6$; (3) $\sqrt{3}/2$; (4) ∞ 。

2.15 $\pm 24\times10^{-21}$ e， $F_e=8.1\times10^{-3}\ N$， $F_g=3.7\times10^{-47}\ N$ 。

2.16 1.08×10^{-19} C , 3.47×10^{11} V/m

2.17 $E_z=\dfrac{\rho r_0 g}{3\varepsilon_0 E}=3.075\times10^4$ V/m

2.18 $x^2+(y-\dfrac{d}{1-k^2})^2+z^2=(\dfrac{kd}{1-k^2})^2$

2.19 $\vec{E}=-\dfrac{\rho_l}{2\pi\varepsilon_0 a}\hat{y}$, $y=a\sqrt{\pi/2}$. (y 轴自圆心指向圆弧中点).

2.20 $\rho=-\varepsilon_0 a^2\dfrac{e^{-ar}}{r}$, $Q_0=4\pi\varepsilon_0$ (Q_0 是位于原点的点电荷)

2.21 $\vec{p}=\hat{z}\dfrac{4}{3}\pi a^3\rho_0$, $V=\dfrac{\rho_0}{3\varepsilon_0}\cdot\dfrac{a^3}{r^2}\cos\theta$

2.23 (1) 8.98×10^{-5} N , (2) 4.08×10^{-5} N , (3) 1.11×10^{-6} N

2.24 $U=\dfrac{Q}{4\pi\varepsilon_0 r}=143.8$ kV

2.25 $E=E_0\sqrt{\sin^2\theta_0+\dfrac{1}{\varepsilon_r}\cos^2\theta_0}$

$\theta=\tan^{-1}(\varepsilon_r\tan\theta_0)$

$\rho_{ps}=\dfrac{\varepsilon_r-1}{\varepsilon_r}\varepsilon_0 E_0\cos\theta_0$

2.27 (1) $\rho_p=-\dfrac{K}{r^2}$, $\rho_{ps}=\dfrac{K}{R}$;

(2) $\rho=\dfrac{\varepsilon_r}{\varepsilon_r-1}\cdot\dfrac{K}{r^2}$;

(3) $U=\dfrac{K}{\varepsilon_0(\varepsilon_r-1)}\ln\dfrac{R}{r}+\dfrac{\varepsilon_r K}{\varepsilon_0(\varepsilon_r-1)}$ $(r\le R)$

$U=\dfrac{\varepsilon_r KR}{\varepsilon_0(\varepsilon_r-1)r}$ $(r\ge R)$

2.28 $\nabla^2 U+\dfrac{1}{\varepsilon}\nabla\varepsilon\cdot\nabla U=0$

2.29 $q_1=\dfrac{4\pi\varepsilon_0 abcU-abQ}{bc-ac+ab}$;

$r<a$: $U=U$, $\vec{E}=0$

$a<r<b$: $U=\dfrac{q_1}{4\pi\varepsilon_0 r}+\dfrac{-q_1}{4\pi\varepsilon_0 b}+\dfrac{Q+q_1}{4\pi\varepsilon_0 c}$, $\vec{E}=\hat{r}\dfrac{q_1}{4\pi\varepsilon_0 r^2}$;

$b<r<c$: $U=\dfrac{Q+q_1}{4\pi\varepsilon_0 c}$, $\vec{E}=0$;

$r>c$: $U=\dfrac{Q+q_1}{4\pi\varepsilon_0 r}$, $\vec{E}=\hat{r}\dfrac{Q+q_1}{4\pi\varepsilon_0 r^2}$

2.30 上板: $\rho_{sa}=6.50\times10^{-6}\ \text{C/m}^2$, $\rho_{sb}=-4.88\times10^{-6}\ \text{C/m}^2$;

中板: $\rho_{sa}=4.88\times10^{-6}\ \text{C/m}^2$, $\rho_{sb}=8.12\times10^{-6}\ \text{C/m}^2$;

下板: $\rho_{sa}=-8.12\times10^{-6}\ \text{C/m}^2$, $\rho_{sb}=6.50\times10^{-6}\ \text{C/m}^2$

2.31 $\dfrac{b}{a}=e\approx2.718$, $E_{\min}=e\dfrac{U_0}{b}$

2.32 $r_0=\dfrac{\varepsilon_1}{\varepsilon_2}a$

2.33 $U_1=\dfrac{rP}{3\varepsilon_0}\cos\theta \quad (r<a)$

$U_2=\dfrac{a^3P}{3\varepsilon_0 r^2}\cos\theta \quad (r>a)$

2.34 答: ε_r 应与 ρ 成反比关系，束缚电荷体密度应为零。

2.36 $U_1=\dfrac{Q}{4\pi\varepsilon_0}[\dfrac{1}{c}-\dfrac{1}{b}+\dfrac{\varepsilon_r a+t}{\varepsilon_r(a+t)a}] \quad (r\le a)$

$U_2=\dfrac{Q}{4\pi\varepsilon_0}[\dfrac{1}{c}-\dfrac{1}{b}+\dfrac{\varepsilon_r-1}{\varepsilon_r(a+t)}+\dfrac{1}{\varepsilon_r r}] \quad (a\le r\le a+t)$

$U_3=\dfrac{Q}{4\pi\varepsilon_0}[\dfrac{1}{c}-\dfrac{1}{b}+\dfrac{1}{r}] \quad (a+t\le r\le b)$

$U_4=\dfrac{Q}{4\pi\varepsilon_0 c} \quad (b\le r\le c)$

$U_5=\dfrac{Q}{4\pi\varepsilon_0 r} \quad (r\ge c)$

2.37 $\vec{E}_2=2y\hat{x}-3x\hat{y}+\dfrac{10}{3}\hat{z} \quad (z=0)$

2.38 $\rho_{ps}=\dfrac{3(\varepsilon-\varepsilon_{0)}}{\varepsilon+2\varepsilon_0}\cos\theta$

2.39 $Q=1.77\times10^{-8}$ C , $W_e=1.77\times10^{-6}$ J , $F=3.54\times10^{-4}$ N.

2.40 233 pF , 3.5×10^{-7} J ，焦耳热损耗。

2.41 27 μC , 135 μC , 405 μC , 13.5 V , 27 V , 40.5 V

2.43 $U_1=\dfrac{\varepsilon_2 d_1}{\varepsilon_2 d_1+\varepsilon_1 d_2}U_0$, $U_2=\dfrac{\varepsilon_1 d_2}{\varepsilon_2 d_1+\varepsilon_1 d_2}U_0$, $\dfrac{w_{e1}}{w_{e2}}=\dfrac{\varepsilon_2}{\varepsilon_1}$

2.44 $W_e=\dfrac{1}{8\pi\varepsilon_0}(\dfrac{Q_1^2}{a_1}+\dfrac{Q_2^2}{a_2}+\dfrac{2Q_1Q_2}{R})$, $F_R=\dfrac{1}{4\pi\varepsilon_0}\cdot\dfrac{Q_1Q_2}{R}$

2.45 $A=\dfrac{Q^2(b-a)(\varepsilon_r-1)}{8\pi ab\varepsilon_0\varepsilon_r}$

2.46 5.31×10^{-10} F/m^2

2.47　2.1

2.48　$C = 2\pi(\varepsilon_1 + \varepsilon_2)a$ ，$W_e = \dfrac{Q^2}{4\pi(\varepsilon_1 + \varepsilon_2)a}$

2.49　$C = \dfrac{\varepsilon\varphi_0 + \varepsilon_0(2\pi - \varphi_0)}{\ln\dfrac{b}{a}}$

习 题 三

3.1　4×10^{10} 个

3.2　$\vec{J} = \hat{\varphi}\dfrac{3Q}{4\pi a^3}\omega r\sin\theta$ ，$I = \dfrac{Q\omega}{2\pi}$

3.4　$I_{铁} \approx 20\ \Omega$ ，$I_{水} \approx 0$

3.5　(1)　$3.0\times10^{13}\ \Omega\cdot\mathrm{m}$ ；(2)　$196\ \Omega$

3.6　(1)　$2.19\times10^{-5}\ \Omega$ ；(2)　$2.28\times10^{3}\ \mathrm{A}$

(3)　$1.43\times10^{6}\ \mathrm{A/m^2}$ ；(4)　$2.50\times10^{-2}\ \mathrm{V/m}$

(5)　$1.14\times10^{2}\ \mathrm{W}$ ；(6)　$1.05\times10^{-4}\ \mathrm{m/s}$

3.7　(1)　$2.21\times10^{8}\ \Omega$ ；(2)　$4.52\times10^{-7}\ \mathrm{A}$

3.8　$\vec{E}_1 = \hat{r}\dfrac{U_0}{(\dfrac{1}{\sigma_2}\ln\dfrac{b}{r_0} + \dfrac{1}{\sigma_1}\ln\dfrac{r_0}{a})\sigma_1 r}$

$\vec{E}_2 = \hat{r}\dfrac{U_0}{(\dfrac{1}{\sigma_2}\ln\dfrac{b}{r_0} + \dfrac{1}{\sigma_1}\ln\dfrac{r_0}{a})\sigma_2 r}$

$\rho_{s1} = \dfrac{U_0}{(\dfrac{1}{\sigma_2}\ln\dfrac{b}{r_0} + \dfrac{1}{\sigma_1}\ln\dfrac{r_0}{a})}(\dfrac{\varepsilon_1}{\sigma_1} - \dfrac{\varepsilon_2}{\sigma_2})$

3.10　$\sigma_2 = \dfrac{1}{3}\times10^{7}\ \mathrm{S/m}$ ；$J_1 = 0.637\times10^{6}\ \mathrm{A/m^2}$ ；

$J_2 = 0.212\times10^{6}\ \mathrm{A/m^2}$ ；$P = 6.37\ \mathrm{kW}$

3.11　$R = \dfrac{1}{4\pi k\sigma_0}\ln\dfrac{r_2(r_1 + k)}{r_1(r_2 + k)}$

3.12　(1)　$\vec{J} = \hat{r}\dfrac{U_0}{Kr^2}$ ；$\rho_{sa} = \dfrac{\varepsilon_1 U_0}{\sigma_1 a^2 K}$ ；

$\rho_{sb} = \dfrac{U_0}{b^2K}(\dfrac{\varepsilon_2}{\sigma_2} - \dfrac{\varepsilon_1}{\sigma_1})$ ；$\rho_{sc} = -\dfrac{\varepsilon_2 U_0}{\sigma_2 c^2 K}$ ；

(2)　$R = \dfrac{K}{4\pi}$.　$K = \dfrac{b-a}{\sigma_1 ab} + \dfrac{c-b}{\sigma_2 bc}$

3.13　$\sigma_1 = 1.5\times10^{-11}\ \mathrm{S/m}$

3.14　$R = \dfrac{1}{4\pi\sigma}(\dfrac{1}{a_1} + \dfrac{1}{a_2} - \dfrac{2}{d})$

习 题 四

4.1 （1） 1.14×10^{-3} T ， $\vec{B}$ 的方向垂直纸面向外；（2） 1.57×10^{-8} s。

4.2 $T=3.59\times10^{-10}$ s ， $h=1.66\times10^{-4}$ m ， $r=1.51\times10^{-3}$ m .

4.3 （1） -2.23×10^{-5} V ， （2） 无影响。

4.4 $F_m/F_e=\varepsilon_0\mu_0 v=(v/c)^2$

4.5 $F=\mu_0\dfrac{I_1I_2}{2\pi d}L$

4.6 (1) $\dfrac{\mu_0 I}{2a}$ ； (2) $\dfrac{\mu_0 I}{4a}$ ； (3) $\dfrac{\mu_0 I}{2a}(\dfrac{1}{\pi}+\dfrac{1}{2})$

4.7 (1) $B_z=\dfrac{\mu_0 I}{4\pi}\cdot\dfrac{NR^2\sin(2\pi/N)}{[z^2+R^2\cos^2(\pi/N)]\sqrt{z^2+R^2}}$；

(2) $B_z=\dfrac{9\mu_0 IR^2}{2\pi(12z^2+R^2)\sqrt{3z^2+R^2}}$；

$B_z=\dfrac{2\sqrt{2}\mu_0 IR^2}{\pi(4z^2+R^2)\sqrt{2z^2+R^2}}$

(3) $B_z=\dfrac{\mu_0 IR^2}{2(z^2+R^2)^{3/2}}$

(4) $B_z\approx\dfrac{\mu_0 IS}{2\pi z^3}$

其中 a 为多边形的边长，S 为面积。

4.8 $R=\dfrac{\pi a}{2\sqrt{2}}$

4.9 $\vec{B}=\hat{x}\dfrac{\mu_0 IN}{2L}[\dfrac{L-x}{\sqrt{(L-x)^2+a^2}}+\dfrac{x}{\sqrt{x^2+a^2}}]$ x 是从螺线管一端算起的距离。

4.10 （1） $B=\dfrac{\mu_0 IN}{2\pi(R+r\cos\theta)}$；

(2) $\Phi_m=\mu_0 IN(R-\sqrt{R^2-a^2})$；

(3) $B_{av}=\dfrac{\mu_0 IN}{\pi a^2}(R-\sqrt{R^2-a^2})$.

4.11 $F_x=\mu_0 I_1 I_2(1-\dfrac{d}{\sqrt{d^2-a^2}})$.

4.12 $\vec{A}=-\hat{z}\dfrac{\mu_0 J_0}{9}r^3+\vec{C}$ ， $\vec{B}=\hat{\varphi}\dfrac{\mu_0 J_0}{3}r^2$ $(r\le a)$

$\vec{A}=-\hat{z}\dfrac{\mu_0 J_0}{3}a^3\ln r+\vec{D}$ ， $\vec{B}=\hat{\varphi}\dfrac{\mu_0 J_0}{3r}a^3$ $(r\ge a)$

其中 $\vec{C}$ 和 $\vec{D}$ 是常矢量.

4.15 $I=4I'$

4.16 $\vec{A}=\dfrac{\mu_0 Iab}{4\pi r^2}(\hat{x}\sin\varphi+\hat{y}\cos\varphi)\sin\theta$

4.17 圆柱外： $\vec{B}=\dfrac{\mu_0 J}{2}\hat{z}\times(\dfrac{b^2\vec{r}}{r^2}-\dfrac{a^2\vec{r}'}{r'^2})$

圆柱内： $\vec{B}=\dfrac{\mu_0 J}{2}\hat{z}\times(\vec{r}-\dfrac{a^2\vec{r}'}{r'^2})$

空腔内： $\vec{B}=\dfrac{\mu_0 J}{2}\hat{z}\times\vec{d}$

式中的$\vec{r}$和$\vec{r}'$分别是导体柱轴线和空腔轴线到场点的位置矢量。

4.18 $H_x=\dfrac{I}{4\pi b}\ln\dfrac{d^2+b_1^2}{d^2+b_2^2}$

$H_y=\dfrac{I}{4\pi b}(tg^{-1}\dfrac{b_1}{d}+tg^{-1}\dfrac{b_2}{d})$

4.20 $\vec{J}_m=0$ ， $\vec{J}_{ms}=\hat{\varphi}M_0\sin\theta$

4.21 $\vec{J}_m=0$ ， $\vec{J}_{ms}=\hat{\varphi}(Aa^2\cos^2\theta\sin\theta+B\sin\theta)$

$\rho_{ms}=Aa^2\cos^3\theta+B\cos\theta$

4.22 $H_\varphi=\dfrac{Ir}{2\pi a^2}$ ， $B_\varphi=\dfrac{\mu I r}{2\pi a^2}$ ， $M_\varphi=\dfrac{(\mu_r-1)Ir}{2\pi a^2}$ $(r\le a)$；

$H_\varphi=\dfrac{I}{2\pi r}$ $(r\ge a)$ ， $B_\varphi=\dfrac{\mu_0 I}{2\pi r}$ $(a\le r\le b, r\ge c)$；

$B_\varphi=\dfrac{\mu I}{2\pi r}$ ， $M_\varphi=\dfrac{(\mu_r-1)I}{2\pi r}$ $(b\le r\le c)$；

$\vec{J}_{ms}=-\hat{z}\dfrac{(\mu_r-1)I}{2\pi a}$ $(r=a)$，

$\vec{J}_{ms}=\hat{z}\dfrac{(\mu_r-1)I}{2\pi b}$ $(r=b)$，

$\vec{J}_{ms}=-\hat{z}\dfrac{(\mu_r-1)I}{2\pi c}$ $(r=c)$.

4.23 $H_\varphi=\dfrac{I}{2\pi r}\dfrac{c^2-r^2}{c^2-b^2}$ ， $B_\varphi=\mu H_\varphi$ ， $M_\varphi=(\mu_r-1)H_\varphi$ $(b\le r\le c)$

$H_\varphi=B_\varphi=0$ $(r>c)$ ， $J_{ms}=0$ $(r=c)$.

4.24 (1) $H_2=5.23$ A/m ， $\theta_2=89.3^\circ$ ； (2) $B_2=6.57\times10^{-3}$ T

4.25 (1) 2×10^{-2} T， (2) 32 A/m ， (3) 1.59×10^4 A/m，

(4) 6.26×10^{-4} H/m ，497 ， (5) 1.59×10^4 A/m .

4.26 (1) 7.57 $\text{A}\cdot\text{m}^2$ ， (2) 11.3 N·m .

4.27 4.79×10^3安匝.

4.28 $m=1.2\times10^{-4}$ $\text{A}\cdot\text{m}^2$.

4.29 $\vec{A}_1=\hat{\varphi}\mu_0\dfrac{M}{3}r\sin\theta$ ， $\vec{B}_1=\dfrac{2}{3}\mu_0\vec{M}$ ， $\vec{H}_1=-\dfrac{1}{3}\vec{M}$ $(r<a)$；

$$\vec{A}_2 = \hat{\varphi}\mu_0 \frac{M a^3}{3r^2}\sin\theta \quad (r > a);$$

$$\vec{B}_2 = \frac{\mu_0 M a^3}{3r^3}(\hat{r}2\cos\theta + \hat{\theta}\sin\theta) \quad , \quad \vec{H}_2 = \frac{M a^3}{3r^3}(\hat{r}2\cos\theta + \hat{\theta}\sin\theta) \quad (r > a)$$

4.30 $U_{m1} = \frac{M}{3} r\cos\theta$, $U_{m2} = \frac{M a^3}{3r^2}\cos\theta$.磁场与 4.29 题相同。

4.31 $U_m = \frac{M_0 \pi a_0^2 l}{4\pi r^2}\cos\theta$, $\vec{H} = \frac{M_0 \pi a_0^2 l}{4\pi r^3}(\hat{r}2\cos\theta + \hat{\theta}\sin\theta)$.

4.32 $\vec{B} = \hat{z}\frac{\mu_0 Q\omega}{6\pi a} \quad (r < a)$, $\vec{B} = \frac{\mu_0 Q\omega a^2}{12\pi r^3}(\hat{r}2\cos\theta + \hat{\theta}\sin\theta) \quad (r > a)$

4.33 $\vec{B} = \hat{\varphi}\frac{\mu_0 \mu I}{\pi(\mu_0 + \mu) r} \quad (x > 0 \quad , x < 0)$

$$\vec{H}_1 = \hat{\varphi}\frac{\mu_0 I}{\pi(\mu_0 + \mu) r} \quad (x < 0) \quad , \quad \vec{H}_1 = \hat{\varphi}\frac{\mu I}{\pi(\mu_0 + \mu) r} \quad (x > 0)$$

4.35 $U_m = \frac{Mh}{2}(1 - \frac{z}{\sqrt{a^2 + z^2}})$, $\vec{H} = \hat{z}\frac{Mh}{2}\frac{a^2}{(a^2 + z^2)^{3/2}}$.

4.36 $$\vec{T} = \frac{\mu_0 m_1 m_2}{4\pi r^3}\{-\hat{z}3\cos\theta_1 \sin\theta_1 \sin(\theta_1 + \theta_2)\sin\varphi$$
$$+ \hat{x}(3\cos^2\theta_1 - 1)\sin(\theta_1 + \theta_2)\sin\varphi$$
$$+ \hat{y}[3\cos\theta_1 \sin\theta_1 \cos(\theta_1 + \theta_2) - (3\cos^2\theta_1 - 1)\sin(\theta_1 + \theta_2)\cos\varphi]\}$$

$$\theta_2 = tg^{-1}(\frac{1}{2} tg\theta_1)$$

4.37 $R_m = \frac{2\pi}{\mu h \ln\frac{b}{a}}$ A/Wb

第 五 章

5.1 $U = U_0 \frac{\mathrm{sh}\frac{\pi}{a}y}{\mathrm{sh}\frac{\pi}{a}b}\sin\frac{\pi}{a}x$

5.2 $U = \frac{4U_0}{\pi}\sum_{n=1,3,5\cdots}^{\infty}\frac{1}{n}\sin(\frac{n\pi}{a}x)\, e^{-\frac{n\pi}{a}y}$

5.3 $U = \sum_{n=1,3,5\cdots}^{\infty}\frac{4\sin(\frac{n\pi}{b}y)}{n\pi\ \mathrm{sh}(n\pi a/b)}[U_1 \mathrm{sh}(\frac{n\pi}{b}x) + U_2 \mathrm{sh}\frac{n\pi}{b}(a - x)]$

5.4 $U = E_0(\frac{a^2}{r} - r)\cos\varphi$

5.6 $U = \sum_{n=1,3,5\cdots}^{\infty}\frac{4U_0}{n\pi}\left[\frac{r^n + (a^2/r)^n}{b^n + (a^2/b)^n}\right]\sin n\varphi$

5.7 $U=-\sum_{n=1,2,3\cdots}^{\infty}\frac{4U_0}{n\pi}\left(\frac{r}{a}\right)^n\sin n\varphi$

5.8 $U_1=-E_0\frac{3\varepsilon_2}{\varepsilon_1+2\varepsilon_2}r\cos\theta\quad(r\le a)$

$U_2=\left(-r+\frac{\varepsilon_1-\varepsilon_2}{\varepsilon_1+2\varepsilon_2}\frac{a^3}{r^2}\right)E_0\cos\theta\quad(r\ge a)$

5.9 $U=\frac{1-a/r}{b-a}bU_2-\frac{U_1a^2(r-b^3/r^2)}{b^3-a^3}\cos\theta$

5.11 $W=\frac{q^2}{16\pi\varepsilon_0 h}$

5.12 8:29

5.13 $\vec{F}=-\hat{x}\frac{Q^2}{4\pi\varepsilon_0}\left[\frac{ad}{(d^2-a^2)^2}-\frac{ad}{(d^2+a^2)^2}+\frac{1}{4d^2}\right]$

$\rho_s=-\frac{Q}{4\pi a}\left[\frac{d+a}{(d-a)^2}-\frac{d-a}{(d+a)^2}\right]$

5.14 $f=\frac{\rho_l^2}{4\pi\varepsilon_0 b}$

5.17 $U=0.48U_0$

5.19 (1) $U=\frac{U_0\,\mathrm{sh}\left[\left(\frac{\pi}{a}\right)^2+\left(\frac{\pi}{b}\right)^2\right]^{1/2}z}{\mathrm{sh}\left[\left(\frac{\pi}{\mathrm{a}}\right)^2+\left(\frac{\pi}{\mathrm{b}}\right)^2\right]^{1/2}c}\sin\frac{\pi}{a}x\ \sin\frac{\pi}{b}y$

(2) $U=\frac{16U_0}{\pi^2}\sum_{n=1}^{\infty}\sum_{m=1}^{\infty}\frac{\sin\left(\frac{2n-1}{a}\pi x\right)\sin\left(\frac{2m-1}{b}\pi y\right)}{(2n-1)(2m-1)}\times\frac{\mathrm{sh}\left[\left(\frac{2n-1}{a}\right)^2+\left(\frac{2m-1}{b}\right)^2\right]^{1/2}\pi z}{\mathrm{sh}\left[\left(\frac{2n-1}{a}\right)^2+\left(\frac{2m-1}{b}\right)^2\right]^{1/2}\pi c}$

5.20 $U=\sum_{n=1}^{\infty}(-1)^n\frac{2U_0}{n\pi}\sin\frac{n\pi}{a}x\ e^{-\frac{n\pi}{a}y}+\frac{U_0}{a}x$

5.21 $U=\sum_{n=1,3,5\cdots}^{\infty}\frac{4U_0}{n\pi}\left(\frac{r}{a}\right)^{2n}\sin 2n\varphi$

5.22 $U=\sum_{n=1,3,5}^{\infty}\frac{4U_0}{n\pi\,\mathrm{I}_0\left(\frac{n\pi}{l}a\right)}\mathrm{I}_0\left(\frac{n\pi}{l}r\right)\sin\frac{n\pi}{l}z$

5.23 $C=\frac{2\pi\varepsilon_0 a}{\ln\left(\tan\frac{\alpha}{2}\right)}$

5.24 $\varepsilon_r=1.196$

5.25 $F=\dfrac{q}{4\pi\varepsilon_0 d^2}\left[Q+\dfrac{a^3(a^2-2d^2)}{d(d^2-a^2)^2}q\right]$

5.26 $C=4\pi\varepsilon_0 a(1+\dfrac{a}{2b}+\dfrac{a^2}{4b^2-a^2}+\cdots\cdots)$

5.27 $2.88\times10^9 q$ V

5.28 $W=-\dfrac{\rho_l}{2\pi\varepsilon_0}\ln(z-z')+C$

第 六 章

6.1 $\mathcal{E}=\dfrac{\mu_0 I_0 a}{2\pi}\omega\sin\omega t\ln\dfrac{(h+b-d)(h+d)}{(h+b+d)(h-d)}$

6.3 $H=0.126$ A/m

6.4 $\rho_p=2(\varepsilon_0-\varepsilon)\omega B$, $\rho_{ps}=(\varepsilon-\varepsilon_0)a\omega B$

6.5 (1) $M=\dfrac{\mu_0 a}{2\pi}\ln\dfrac{b+c}{c}$； (2) $F=\dfrac{\mu_0 a I_1 I_2}{2\pi}\dfrac{b}{c(b+c)}$； (3) $\mathcal{E}=\dfrac{\mu_0 Iab}{2\pi}\dfrac{v}{r(r+b)}$

6.6 $L=\dfrac{\mu_0}{\pi}(a\ln\dfrac{b-r_0}{r_0}+b\ln\dfrac{a-r_0}{r_0})+\dfrac{\mu_0}{4\pi}(a+b)$

6.7 (1) $L_0=\mu n^2\pi a^2$, (2) $W_{m0}=\dfrac{1}{2}\mu n^2 I^2\pi a^2$.

6.8 $W_m=\dfrac{\mu n^2 h I^2}{\pi}\ln\dfrac{b}{a}$

6.9 $F=-\mu_0\dfrac{I_1 I_2}{2\pi D}$

6.11 $\mathcal{E}=\dfrac{1}{2}a^2 B\omega$, $I=7.07\times10^5$ A , $t=6.15$ s .

6.13 (1) $v=\dfrac{RW}{B^2 l^2}(1-e^{-\frac{B^2 l^2}{Rm}t})$, (2) $W=\dfrac{B^2 l^2}{R}\int_0^t v^2 dt$.

6.14 (2) $M=\dfrac{\mu l}{2\pi}(\ln\dfrac{l+\sqrt{l^2+D^2}}{D}-\dfrac{\sqrt{l^2+D^2}-D}{l})$

6.15 $M=\mu_0(h-\sqrt{h^2-a^2})$

6.16 $M=\dfrac{\mu_0 NS}{(l^2+4a^2)^{1/2}}$

6.17 (1) $M=\mu_0 n\pi a^2\dfrac{l}{\sqrt{l^2+a^2}}$

(2) $\mathcal{E}=\mu_0 n\pi a^2 I_m\omega\dfrac{l}{\sqrt{l^2+a^2}}\sin\omega t$

6.18 $\vec{F}=-\hat{x}\mu_0 I_1 I_2(\dfrac{h}{\sqrt{h^2-a^2}}-1)$

6.19 $f=\dfrac{\mu_0 I^2}{2a}$ (推力)

6.20 $f=\dfrac{1}{2}\mu_0 n I^2$

6.21 (1) $M=\mu_0\sqrt{ab}[(\dfrac{2}{k}-k)K(k)-\dfrac{2}{k}E(k)]$

其中: $k=2\sqrt{ab}[(a+b)^2+h^2]^{-1/2}$

$K(k)=\int_0^{\pi/2}\dfrac{dx}{(1-k^2\sin^2 x)^{1/2}}$, $E(k)=\int_0^{\pi/2}(1-k^2\sin^2 x)^{1/2}dx$

(2) $M\approx\dfrac{\pi\mu_0 a^2 b^2}{2[(a+b)^2+h^2]^{3/2}}$

(3) $F=-\dfrac{3\pi\mu_0 a^2 b^2 h I_1 I_2}{2[(a+b)^2+h^2]^{5/2}}$ (引力)

第 七 章

7.1 $\vec{J}_d=\dfrac{25}{\pi}(\hat{x}\sin 10^3 t-\hat{y}\cos 10^3 t)$ A/m^2

7.2 $I_d=\dfrac{2\pi\varepsilon_0\omega L}{\ln\dfrac{b}{a}}U_0\cos\omega t$

7.3 $\nabla\times\vec{B}=\mu\vec{J}_e+\mu\varepsilon\dfrac{\partial\vec{E}}{\partial t}+\dfrac{\nabla\mu\times\vec{B}}{\mu}$

$\nabla\times\vec{E}=-\dfrac{\partial\vec{B}}{\partial t}$

$\nabla\cdot\vec{B}=0$

$\nabla\cdot\vec{E}+\dfrac{\nabla\varepsilon}{\varepsilon}\cdot\vec{E}=\dfrac{\rho}{\varepsilon}$

7.4 $k=17.32\pi\quad rad/m$

$\vec{H}=-\hat{x}0.229\times10^{-3}\sin(10\pi x)\cos(6\pi\times10^9 t-54.41z)$

$-z0.133\times10^{-3}\cos(10\pi x)\sin(6\pi\times10^9 t-54.41z)$ A/m

7.5 (1) $\vec{E}=\hat{z}\dfrac{U_0}{d}$, $\vec{H}=\hat{\varphi}\dfrac{\sigma U_0 r}{2d}$, $\vec{S}=-\hat{r}\dfrac{\sigma U_0^2 r}{2d^2}$

(2) $P=-\int_s\vec{S}\cdot d\vec{s}=\dfrac{U_0^2}{R}$

7.8 (1) $\vec{E}=\hat{y}2e^{j\frac{2\pi}{3}z}$ V/m ,

(2) $\vec{H}(\vec{r},t)=-\hat{x}\dfrac{1}{60\pi}\cos(2\pi\times10^8 t-\dfrac{2\pi}{3}z)$ A/m

7.9 (1) $\vec{S}=-\hat{x}\dfrac{j5}{24\pi}\sin(2\pi x)+\hat{z}\dfrac{5}{12\pi}\sin^2(\pi x)$ W/m^2

$$< \vec{S} >= \hat{z}\frac{5}{12\pi}\sin^2(\pi x) \qquad \text{W/m}^2$$

(2) $< w_e >= 25\varepsilon_0 \sin^2(\pi x) \quad \text{J/m}^3$ ， $< w_m >= \mu_0 \frac{1}{(24\pi)^2} \quad \text{J/m}^3$

7.10 (1) U=常量；

(2) $\vec{E}(\vec{r},t) = \hat{z}\omega \cos kx \sin \omega t \quad \text{V/m}$

(3) $\vec{H}(\vec{r},t) = \hat{y}\frac{k}{\mu}\sin kx \cos \omega t \quad \text{A/m}$

7.11 $\vec{E} = \{\hat{r}2\cos\theta[\frac{1}{kr} - \frac{j}{(kr)^2}] + \hat{\theta}\sin\theta[j + \frac{1}{kr} - \frac{j}{(kr)^2}]\}\frac{\omega A_0}{r}e^{-jkr}$

$\vec{H} = \hat{\varphi}\frac{A_0}{\mu r}\sin\theta(jk + \frac{1}{r})e^{-jkr}$

7.12 $I_d = 0.28 \quad \text{A}$ ， $H(a) = 0.445 \quad \text{A/m}$.

7.13 $\vec{J}_d = \frac{qv}{4\pi}[\hat{r}\frac{3r(z-vt)}{R^5} + \hat{z}\frac{2(z-vt)^2 - r^2}{R^5}]$

7.15 (1) $\vec{H} = -\hat{x}\frac{k}{\omega \mu_0}E_m \sin(\omega t - kz)$

(3) $< \vec{S} >= \hat{z}\frac{E_m^2}{2}\varepsilon_0 c$

7.18 $\vec{S}(\vec{r},t) = \frac{H_m^{\ 2}}{r^3\omega\varepsilon_0}\left\{-\hat{\theta}\sin\theta\cos\theta\sin 2(\omega t - kr) + \hat{r}rk\sin^2\theta\cos^2(\omega t - kr)\right\}$

$< \vec{S} >= \hat{r}\frac{k}{2\varepsilon_0}\frac{H_m^2}{r^2}\sin^2\theta$

7.20 $\vec{S}(\vec{r},t) = \hat{r}\frac{120\pi}{r^2}\sin^2\theta\cos^2(\omega t - kr) \qquad \text{W/m}^2$

$< P >= 789 \quad \text{W}$

7.21 (1) $\vec{H} = \hat{y}\frac{k}{\omega \mu_0}E_m e^{-jkz}$

(2) $\rho_s(x=0) = \varepsilon_0 E_m \cos(\omega t - kz)$

$\rho_s(x=d) = -\varepsilon_0 E_m \cos(\omega t - kz)$

$\vec{J}_s(x=0) = \hat{z}\frac{k}{\omega \mu_0}E_m \cos(\omega t - kz)$

$\vec{J}_s(x=d) = -\hat{z}\frac{k}{\omega \mu_0}E_m \cos(\omega t - kz)$

7.22 (1) $\vec{H} = E_m\left[\hat{x}\frac{j\beta}{\omega\mu}\sin\frac{m\pi x}{a} + \hat{z}\frac{m\pi}{a\omega\mu}\cos\frac{m\pi x}{a}\right]e^{-j\beta z}$

(2) $\vec{S}(\vec{r},t) = \hat{z}\frac{E_m^{\ 2}\beta}{\omega\mu_0}\sin^2\frac{m\pi x}{a}\sin^2(\omega t - \beta z)$

$$+\hat{x}\frac{E_m{}^2 m\pi}{2\omega\mu_0 a}\sin\frac{m\pi x}{a}\cos\frac{m\pi x}{a}\sin 2(\omega t-\beta z)$$

$$\left\langle \vec{S}\right\rangle=\frac{1}{2}\mathrm{Re}\left[\vec{E}\times\vec{H}^*\right]=\hat{z}\frac{E_m{}^2\beta}{2\omega\mu_0}\sin^2\frac{m\pi x}{a}$$

(3) $<P>=\frac{1}{4}\frac{\beta}{\omega\mu}abE_m^2$

第 八 章

8.1 $f=\frac{\omega}{2\pi}=3\times10^8\quad \mathrm{Hz}$

$k=2\pi\quad \mathrm{rad/m}$

$\vec{k}=\hat{z}2\pi$

$\lambda=\frac{2\pi}{k}=1\quad \mathrm{m}$

$\vec{H}(r,t)=\hat{y}10^{-2}\cos(6\pi\times10^8-2\pi z)\quad \mathrm{A/m}$

8.2 $\vec{H}(z,t)=\left(\hat{x}\frac{1}{30\pi}+\hat{y}\frac{1}{40\pi}\right)\cos(6\times10^9 t-20\pi z)\quad \mathrm{A/m}$

$<\vec{S}>=\hat{z}\frac{5}{48\pi}\quad \mathrm{W/m^2}$

8.3 (1) $k=\omega\sqrt{\mu\varepsilon}=0.6\pi\quad \mathrm{rad/m}$

$\eta=\sqrt{\mu/\varepsilon}=42\quad \Omega$

$v_p=\frac{\omega}{k}=\frac{1}{3}\times10^8\quad \mathrm{m/s}$

$\lambda=\frac{v_p}{f}=\frac{10}{3}\quad \mathrm{m}$

(2) $\vec{E}(\vec{r},t)=\hat{x}0.1\cos(2\times10^7 t-0.6\pi y)\quad \mathrm{V/m}$

$\vec{E}=\hat{x}0.1\,e^{-j0.6\pi y}$

(3) $\vec{H}(\vec{r},t)=-\hat{z}2.381\times10^{-3}\cos(2\pi\times10^7 t-0.6\pi y)\quad \mathrm{A/m}$

$\vec{H}=\frac{\vec{k}}{\omega\mu}\times\vec{E}=-\hat{z}2.381\times10^{-3}e^{-j0.6\pi y}$

(4) $<\vec{S}>=\hat{y}1.190\times10^{-6}\quad \mathrm{W/m^2}$

(5) $k=\frac{\pi}{15}$, $\eta=120\pi$, $v_p=3\times10^8$, $\lambda=30$

8.4 (1) 线极化 ； (2) 圆极化 ，左旋 ； (3) 椭圆极化 ，左旋 ；
(4) 圆极化 ，右旋； (5) 线极化。

8.6 (1) $l_1=1.59\ \mathrm{Km}$, $l_2=1.46\ \mathrm{Km}$

(2) $l_1=100\ \mathrm{m}$, $l_2=23.4\ \mathrm{m}$

8.8 $f<113\ \mathrm{MHz}$ 为良好导体；

$f > 113\ \text{GHz}$ 为低损耗介质。

8.10 (1) $k = 2\pi$ rad/m , $\omega = 6\pi \times 10^8$ rad/s

(2) $$\vec{H}(\vec{r},t) = \frac{1}{120\pi}\{-(3\hat{x}+4\hat{y})\cos[\omega t - 2\pi(0.8x-0.6y) - 53.13^\circ] + 5\hat{z}\cos[\omega t - 2\pi(0.8x-0.6y)]\}\ \text{A/m}$$

(3) $<\vec{S}> = 25(0.8\hat{x} - 0.6\hat{y})$ W/m^2

(4) $<W_e> = 12.5\varepsilon_0 = 1.1\times 10^{-10}$ J/m^3

8.11 (1) 满足；

(2) $\vec{H}_1 = \hat{y}\dfrac{k}{\omega\mu}E_{10}\, e^{-jkz}$, $\vec{H}_2 = 0$

$\vec{E}_1$ 表示电磁波，$\vec{E}_2$ 不表示电磁波。

8.12 (1) $\hat{z}$ 方向；

(2) $f = 3\times 10^9$ Hz；

(3) $\vec{H} = 2.65\times 10^7(-j\hat{x} + \hat{y})e^{-j20\pi z}$

(4) 左旋圆极化；

(5) 2.65×10^{-11} W/m^2。

8.13 (1) $\vec{k} = -0.6\hat{y} + 0.8\hat{z}$；

(2) $\vec{k}\cdot\vec{E} = 0$ ， 是横电磁波；

(3) 右旋椭圆极化波；

(4) $<\vec{S}> = \dfrac{57}{\omega\mu}(-0.6\hat{y} + 0.8\hat{z})$。

8.15 $\vec{E}_a = \hat{x}E_1 + \hat{y}E_2\cos\phi$, $\vec{E}_b = \hat{y}E_2\sin\phi$

$$\vec{H} = \frac{k}{\omega\mu_0}(-\hat{x}E_2 e^{j\varphi} + \hat{y}E_1)e^{-jkz}$$

8.17 $\vec{E}(t) = 2E_m[\hat{x}\cos(\Delta\omega t - \Delta kz) + \hat{y}\sin(\Delta\omega t - \Delta kz)]\cos(\omega t - kz)$

$\Delta\omega = \dfrac{1}{2}(\omega_R - \omega_L)$, $\Delta k = \dfrac{1}{2}(k_R - k_L)$

$\Delta\omega > 0$ 为右旋 ， $\Delta\omega < 0$ 为左旋

$\Delta\omega = 0$ 为线极化波。

8.19 $\delta = \dfrac{1}{\alpha} = \dfrac{2}{\omega}\dfrac{1}{\sqrt{\omega\varepsilon'}}\dfrac{1}{\tan\delta} = 199.7$ m , $\phi = 8.6\times 10^{-3}$ rad

8.21 $E_x = 7.259\times 10^3\, e^{-8.89z}\cos(10^7\pi t - 8.89z + 8.89)$ V/m

$H_y = 2.310\times 10^3\, e^{-8.89z}\cos(10^7\pi t - 8.89z + 8.1)$ A/m

$v_p = 3.53\times 10^6$ m/s

$\lambda = 0.707$ m

8.22 $v_p = \dfrac{\omega}{\beta} = \dfrac{\sqrt{2}}{\sqrt{\omega\varepsilon}}\left[\sqrt{1 + \left(\dfrac{\sigma}{\omega\varepsilon}\right)^2} + 1\right]^{-1/2}$

$$\vec{v}_e = \hat{k}\frac{\sqrt{2}}{\sqrt{\mu\varepsilon}}\left[\sqrt{1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2}+1\right]^{-1/2} = \hat{k}v_p$$

8.23 $v_p = 1.46\times10^8$ m/s

$\lambda = 14.6$ m

$l = 155.2$ m

8.24 $v_g = \frac{A}{2}\sqrt{\lambda}$

8 25 $v_p = \frac{c}{\sqrt{1+\frac{A^2}{B^2-\omega^2}}}$, $v_g = \frac{c\,(B^2-\omega^2)^2}{(B^2-\omega^2)^2+A^2B^2}\sqrt{1-\frac{A^2}{B^2-\omega^2}}$

8.26 (1) $f = 4.775\times10^8$ Hz

(2) $\theta_i = \theta_r = 36.87^\circ$; $\theta_t = 17.46^\circ$

(3) $\vec{k}_r = \hat{x}6-\hat{z}8$ 1/m ; $\vec{k}_t = \hat{x}6+\hat{z}19.08$ 1/m

8.27 R = –0.127 ; T = 0.873

8.29 垂直极化 $E_{r0} = -0.5$, $E_{t0} = 0.5$ V/m

平行极化 $E_{r0} = 0$, $E_{t0} = 0.577$ V/m

8.31 (1) $l = 0.678$ cm

(2) 93.1%

8.32 (1) $\varepsilon_r = 73$

(2) $E_{i0} = 47.6$ V/m , $H_{i0} = 0.126$ A/m

$E_{r0} = -37.6$ V/m , $H_{r0} = 0.1$ A/m

$E_{t0} = 10$ V/m , $H_{i0} = 0.226$ A/m

(3) $\rho = \sqrt{\varepsilon_r}$

8.33 $P_{av} = 1.16\times10^7$ W/m^2

8.35 $s = ab\sqrt{1-\sin^2\theta_i/\varepsilon_r}\,/\cos\theta_i$

8.36 (2) $\theta_i = \theta_B = \tan^{-1}\sqrt{\varepsilon_2/\varepsilon_1} = 63.5^\circ$

8.37 (1) $\mathrm{T}_\perp = 1+\mathrm{R}_\perp = 1.5$

(2) $\mathrm{R}'_\perp = -\mathrm{R}_\perp = -\frac{1}{2}$, $\mathrm{T}'_\perp = 1+\mathrm{R}'_\perp = \frac{1}{2}$

(3) $\mathrm{R}_p = \mathrm{R}'_p$, $\mathrm{T}_p = \mathrm{T}'_p$

8.38 (1) $A = -2$, $\omega = \frac{k_1}{\sqrt{\mu_0\varepsilon_0}} = 1.2\times10^9$ rad/s

(2) $\vec{E}_i = -\eta_0\left(\hat{x}\frac{\sqrt{3}}{2}+\hat{y}2+\hat{z}\frac{1}{2}\right)e^{-j(-2x+2\sqrt{3}z)}$

(3) $\theta_i = 30^\circ$

(4) $\vec{E}_r = \vec{E}_{r\parallel}+\vec{E}_{r\perp} = \left[13.2\pi\left(\sqrt{3}\hat{x}-\hat{z}\right)+74.4\pi\hat{y}\right]e^{j(2x+2\sqrt{3}z)}$

8.40 (1) $\theta_i = \theta_B = 63.4^\circ$

(2) $S_r/S_i = 18\,\%$

8.41 (1) $\vec{E}_r = -(\hat{x} + j\,\hat{y})E_0\, e^{jkz}$

(2) $\vec{E} = (-j\hat{x} + \hat{y})\,2E_0 \sin kz$

(3) $P_{av} = 0$

8.42 $\varepsilon_r = 7.3$

8.43 (1) $d = 3$ cm

(2) $R = 0.0553$

第九章

9.1

	λ_c(cm)	λ_g (cm)	β(rad/cm)	v_g(m/s)	$\eta\,(\Omega)$
TE_{10}	12	6.92	0.91	2.7×10^8	435.2
TE_{01}	8	9.06	0.69	1.98×10^8	569.3
TE_{11}	6.66	13.78	0.46	1.3×10^8	866.1
TM_{11}	6.66	13.78	0.46	1.3×10^8	164.1

9.2 (1) $\lambda = 16$ cm 时不能传输任何模式，

$\lambda = 8$ cm 时能传输 TE_{10} 模式，

$\lambda = 6.5$ cm 时能传输 TE_{10}，TE_{20}，TE_{01} 模；

(2) $2.187\ \text{GHz} < f < 3.959\ \text{GHz}$

9.3 $P_{\max} = 1$ MW

9.4 (1) $\beta = 158$ rad/m，$\eta_{TE_{10}} = 499\ \Omega$

(2) $\beta = 395$ rad/m，$\eta_{TE_{10}} = 201\ \Omega$

(3) $\alpha = 90$ NB/m，$\eta_{TE_{10}} = j443.5\ \Omega$，$l = 0.01$ m

9.5 $a = 2b = 4.758$ cm

9.6

	TE_{11}	TM_{01}	TE_{21}	
$\lambda_c =$	5.12	3.92	3.09	cm
$\lambda_g =$	3.7	4.66	12.52	cm

9.7 $a = 1.33$ cm

9.8 (1) $f_{101} = 6.25\times10^9$ Hz

(2) $f_{101} = 3.125\times10^9$ Hz

9.9 (1) $a = 7.07$ cm

(2) $Q = 19500$

9.10 (1) $\lambda_c = 3\sqrt{2}$ cm，$\lambda_g = 3\sqrt{2}$ cm

(2) $a = 9$ cm，$b = 6$ cm

9.11 (1) $J_{sxm} = 8.49\times10^{-2}$ A/m

(2) $d = 6.25\ cm$

(3) $a = 8.3$ cm

9.12 $l = 3.64$

9.13　$a=6.5$ cm　，　$b=3.5$ cm　，　$\alpha=64.1$ NB/m

9.14　$\sin\dfrac{\pi}{a}x\cos\beta_{10}z=C$

C为积分常数,$|C|<1$。一个C值对应一条磁力线。

9.16　(1)　$\beta=234$ rad/m

$\lambda_g=2.68$ cm

$v_p=2.68\times10^8$ m/s

$\eta_{\mathrm{TE}}=337.4$ Ω

(2)　$\alpha=\alpha_\varepsilon+\alpha_d=0.457+0.73=1.187$ dB/m

9.19　(1)　$\lambda_c=8.53$ ，6.53 ，4.10 ，4.10 cm

(2)　$\lambda_c=7$ cm 时为TE_{11}

$\lambda_c=6$ cm 时为TE_{11}，TM_{01}

$\lambda_c=3$ cm 时为TE_{11}，TM_{01}，TE_{01}，TM_{11}

(3)　$\lambda_g=12.2$ ，8.44 ，3.20 cm

9.20　(1)　TM_{110} ，$f_{110}=\dfrac{1}{2\sqrt{\mu_0\varepsilon_0}}\sqrt{\dfrac{1}{a^2}+\dfrac{1}{b^2}}$

TE_{101} ，$f_{101}=\dfrac{1}{2\sqrt{\mu_0\varepsilon_0}}\sqrt{\dfrac{1}{a^2}+\dfrac{1}{d^2}}$

TM_{110}，TM_{101}，TE_{011} ，$f=\dfrac{1}{\sqrt{\mu_0\varepsilon_0}\sqrt{2}\,a}$

(2)　$w_{av}=\dfrac{\mu_0H_0^2}{8}abd\left(1+\dfrac{a^2}{d^2}\right)=1.55\times10^{-11}H_0^2$ J

9.21　(1)　$H_z=-jH_0J_0(k_cr)\sin\left(\dfrac{l\pi}{d}z\right)$

$H_r=-j\dfrac{l\pi}{k_cd}H_0\,\mathrm{J}_0'(k_cr)\cos\left(\dfrac{l\pi}{d}z\right)$

$E_\varphi=\dfrac{\omega\mu}{k_c}H_0\,\mathrm{J}_0'(k_cr)\sin\left(\dfrac{l\pi}{d}z\right)$

$$f_{01l}=\frac{1}{2\pi\sqrt{\mu\varepsilon}}\sqrt{\left(\frac{3.832}{a}\right)^2+\left(\frac{l\pi}{d}\right)^2}$$

(2)　$l=5$

第 十 章

10.2　(1)　3.77×10^{-4} V/m

(2)　3.265×10^{-5} V/m

(3)　0

10.3　$<S>=1.5$ μ W/m^2

10.5 $F(\alpha)=\cos[\frac{\pi}{2}\cos\alpha]$

10.6 (1) $F_{xy}(\frac{\pi}{2},\varphi)=0$

$F_{xz}(\theta,0)=\left|\sin(kd\cos\theta)\right|$

$F_{yz}(\theta,\frac{\pi}{2})=\left|\cos\theta\sin(kd\cos\theta)\right|$

10.7 $\zeta=-\frac{\pi}{2}$

10.9 $\vec{E}=-j\eta_0\left[\left(k+\frac{1}{jr}-\frac{1}{kr^2}\right)I\vec{l}-\left(k+\frac{3}{jk}-\frac{3}{kr^2}\right)(I\vec{l}\cdot\hat{r})\hat{r}\right]\frac{e^{-jkr}}{4\pi r}$

10.10 $\vec{H}=\frac{k\omega qa}{4\pi r}[\hat{\varphi}\cos\theta\cos\varphi+\hat{\theta}\sin\varphi-j(\hat{\varphi}\cos\theta\sin\varphi-\hat{\theta}\cos\varphi)]\,e^{-jkr}$

$=\frac{k\omega qa}{4\pi r}[\hat{\varphi}\cos\theta+j\hat{\theta}]\;e^{-j(kr+\varphi)}$

$\vec{E}=\frac{k\omega qa}{4\pi r}\eta_0[\hat{\theta}\cos\theta-j\hat{\varphi}]\;e^{-j(kr+\varphi)}$

$<\vec{S}>=\hat{r}\frac{\eta}{2}\left(\frac{k\omega qa}{4\pi r}\right)^2(\cos^2\theta-1)$

10.11 88.4％

10.12 (1) $\vec{H}=\frac{E_0}{\omega\mu_0}\left[\hat{r}\frac{j}{r^2}\mathrm{c}\tan\theta-\hat{\theta}\frac{k}{r}\right]\;e^{-jkr}$

(2) $<S>=\frac{E_0^2}{240\pi r^2}\quad \mathrm{W/m^2}$

(3) $P=\frac{E_0^2}{60}\quad \mathrm{W}$

10.14 $E_{\max}=60\quad \mathrm{mV/m}$

10.15 (1) 沿 z 方向极化；

(2) 圆极化；

(3) 沿 x 方向极化；

(4) 椭圆极化。