参考答案

思考题与习题一

2. (a)$\boldsymbol{c}$ (b)$\frac{\boldsymbol{r}\cdot\boldsymbol{c}}{r}$ (c)$\frac{\boldsymbol{r}\times\boldsymbol{c}}{r}$ (d)0 (e)$-2\boldsymbol{c}$ (f)$4\boldsymbol{c}\cdot\boldsymbol{r}$ (g)$\boldsymbol{c}\times\boldsymbol{r}$ (h)$2\boldsymbol{r}\cdot\boldsymbol{c}$ (i)$3\boldsymbol{c}\times\boldsymbol{r}$
(j)$2c^2\boldsymbol{r}-2(\boldsymbol{c}\cdot\boldsymbol{r})\boldsymbol{c}$ (k)$\frac{3(\boldsymbol{c}\cdot\boldsymbol{r})}{r^5}\boldsymbol{r}-\frac{\boldsymbol{c}}{r^3}$ (l)同 k

3. $8\boldsymbol{i}+8\boldsymbol{j}-16\boldsymbol{k}$

6. (1)提示:利用高斯公式来证明.
(2)提示:以任意一常矢量 $\boldsymbol{c}$ 点乘等式右端.

7. (1) $\sum_{i=1}^{n}q_i\delta(\boldsymbol{R}-\boldsymbol{R}_i)$ (2) $\frac{Q}{4\pi a^2}\delta(\boldsymbol{R}-a)$

8. (1) $I\delta(z-0)$ (2)$I\delta(r-a,z-0)$

思考题与习题二

12. (1)$\boldsymbol{E}=E_0e^{-\frac{\sigma}{\varepsilon}t}\boldsymbol{e}_r,\boldsymbol{B}=0$
(2)$r=R_1$ 处:$\sigma_p=\frac{(\varepsilon-\varepsilon_0)R_2V_1}{R_1(R_2-R_1)}e^{-\frac{\sigma}{\varepsilon}t}$,$r=R_2$ 处:$\sigma_p=\frac{(\varepsilon-\varepsilon_0)R_1V_1}{R_2(R_2-R_1)}e^{-\frac{\sigma}{\varepsilon}t}$

15. 体内 $\boldsymbol{J}_m=0$,柱表面:$\alpha_m=M_1\boldsymbol{e}_\phi$

16. $r=r_1$ 处:$\alpha_m=0$,$r=r_2$ 处:$\alpha_m=\left(1-\frac{\mu}{\mu_0}\right)(r_2^2-r_1^2)\frac{\boldsymbol{J}}{2r_2}$

17. (1)$\boldsymbol{E}=\frac{V_0}{a}\cos\omega t\boldsymbol{k},\boldsymbol{B}_1=-\frac{\mu_0\varepsilon_0\omega V_0}{2d}r\sin\omega t\boldsymbol{e}_\phi$
(2)$I=-\frac{\varepsilon_0\omega\pi a^2}{d}V_0\sin\omega t,\alpha_f=-\frac{\varepsilon_0\omega(r^2-a^2)}{2dr}V_0\sin\omega t\boldsymbol{e}_r$

19. $\boldsymbol{J}_D=-\frac{\varepsilon_0\omega V_0\sin\omega t}{\ln b/a}\cdot\frac{\boldsymbol{e}_r}{r},I_D=-\frac{2\pi\varepsilon_0h\omega V_0}{\ln b/a}\sin\omega t$

20. (1)$\boldsymbol{S}=\frac{IV}{2\pi\ln b/a}\cdot\frac{1}{r^2}\boldsymbol{e}_z,p=IV$ (2)$\boldsymbol{S}_a=-\frac{I^2}{2\pi^2a^3\sigma}\cdot\boldsymbol{e}_r,p=I^2R$

21. 自由电荷:$\sigma_{上}=\frac{\varepsilon_1\sigma_2}{\sigma_1l_1+\sigma_2l_1}V$, $\sigma_{下}=\frac{-\varepsilon_1\sigma_1}{\sigma_1l_2+\sigma_2l_1}V$, $\sigma_{中}=\frac{\sigma_1\varepsilon_2-\sigma_2\varepsilon_1}{\sigma_1l_2+\sigma_2l_1}V$
束缚电荷:$\sigma_{p上}=\frac{(\varepsilon_0-\varepsilon_1)\sigma_2}{\sigma_1l_2+\sigma_2l_1}V$, $\sigma_{p下}=\frac{(\varepsilon_2-\varepsilon_0)\sigma_1}{\sigma_1l_2+\sigma_2l_1}V$, $\sigma_{p中}=\frac{(\varepsilon_1-\varepsilon_0)\sigma_2-(\varepsilon_2-\varepsilon_0)\sigma_1}{\sigma_1l_2+\sigma_2l_1}V$

思考题与习题三

9. $\Phi=\frac{Q}{4\pi\varepsilon_0}\sum_{n=-\infty}^{\infty}\left[\frac{1}{\sqrt{r^2+[z-(2ln+z_0)]^2}}-\frac{1}{\sqrt{r^2+[z-(2ln-z)]^2}}\right]$

10. 选球坐标系:
电荷 Q 的坐标为:(ρ,θ_0,ϕ_0),P 点坐标为:(R,θ,ϕ),$\angle QOP=\alpha$,$\angle Q'OP=\beta$
则壳内任一点 P 的电势为:

$$\phi=\frac{1}{4\pi\varepsilon_0}\left[\frac{Q}{\sqrt{R^2+\rho^2-2R\rho\cos\alpha}}-\frac{Q}{\sqrt{R^2+\rho^2-2R\rho\cos\beta}}-\frac{R_0Q/\rho}{\sqrt{R^2+R_0^4/\rho^2-2RR_0^2/\rho\cos\alpha}}\right.$$

$$+\frac{R_0Q/\rho}{\sqrt{R^2+R_0^4/\rho^2-2RR_0^2/\rho\cos\beta}}\Bigg]$$

$$\cos\alpha=\cos\theta\cos\theta_0+\sin\theta\sin\theta_0\cos(\phi-\phi_0)$$

$$\cos\beta=-\cos\theta\cos\theta_0+\sin\theta\sin\theta_0\cos(\phi-\phi_0)$$

11. $$\phi=\frac{1}{4\pi\varepsilon_0}\left[\frac{1}{\sqrt{(x-b)^2+(y-a)^2+z^2}}-\frac{1}{\sqrt{(x-b)^2+(y+a)^2+z^2}}\right.$$
$$\left.-\frac{1}{\sqrt{(x+b)^2+(y-a)^2+z^2}}+\frac{1}{\sqrt{(x+b)^2+(y+b)^2+z^2}}\right]$$

12. 球外电势：

$$\phi=\frac{1}{4\pi\varepsilon_0}\left[\frac{\boldsymbol{P}\cdot(\boldsymbol{r}-D\boldsymbol{k})}{(r^2+D^2-2rD\cos\theta)^{3/2}}+\frac{\frac{R^3}{D^3}\boldsymbol{P}\cdot\left(\boldsymbol{r}-\frac{R^2}{D}\boldsymbol{k}\right)}{\left(r^2+\frac{R^4}{D^2}-2r\frac{R^2}{D}\cos\theta\right)^{3/2}}-\frac{PR/D^2}{\left(r^2+\frac{R^4}{D^2}-2r\frac{R^2}{D}\cos\theta\right)^{1/2}}\right]$$

13. (1)$$F=-\frac{Q^2bc}{4\pi\varepsilon_0(b^2-c^2)^2}$$

(2)洞外：$$\sigma_1=\frac{\varepsilon_1(Q+q)}{2\pi(\varepsilon_1+\varepsilon_2)a^2},\quad \sigma_2=\frac{\varepsilon_2(Q+q)}{2\pi(\varepsilon_1+\varepsilon_2)a^2},$$

$$\sigma_{P_1}=\frac{(\varepsilon_0-\varepsilon_1)(Q+q)}{2\pi(\varepsilon_1+\varepsilon_2)a^2},\quad \sigma_{P_2}=\frac{(\varepsilon_0-\varepsilon_2)(Q+q)}{2\pi(\varepsilon_1+\varepsilon_2)a^2}$$

洞内表面：$$\sigma=\frac{Q\cdot(c^2-b^2)}{4\pi b(b^2+c^2-2bc\cos\theta)^{3/2}}$$

14. $r<a$，$$\phi=\frac{-\rho r^2}{6\varepsilon}+\frac{Q+q}{4\pi\varepsilon_0 b}+\frac{\rho a^2}{6\varepsilon}$$

$a\leqslant r\leqslant b$，$$\phi=\frac{\rho a^2}{6\varepsilon}$$

$r>b$，$$\phi=\frac{Q+q}{4\pi\varepsilon_0 r}$$ 其中：$q=\frac{4}{3}\pi a^3\cdot\rho$

$r=b$ 面上：$$\sigma_b=\frac{q+Q}{4\pi b^2}$$

$r=a$ 面上：$$\sigma_a=-\frac{\rho a}{3}$$

总电偶极矩：$\boldsymbol{P}=0$

15. $r<a$，$$\phi_1=\frac{Q}{4\pi\varepsilon_1 r}+\sum_{n=0}^{\infty}\frac{Q(n+1)b^n(\varepsilon_1-\varepsilon_2)}{4\pi\varepsilon_1 a^{2n+1}[n\varepsilon_1+(n+1)\varepsilon_2]}r^nP_n(\cos\theta)$$

$r>a$，$$\phi_2=\sum_{n=0}^{\infty}\frac{Qb^n(2n+1)}{4\pi[n\varepsilon_1+(n+1)\varepsilon_2]r^{n+1}}P_n(\cos\theta)$$

$r=a_{处}$：$$\sigma_P=\frac{Q\varepsilon_0}{4\pi\varepsilon_1}(\varepsilon_1-\varepsilon_0)\sum_{n=0}^{\infty}\frac{(n+1)(2n+1)b^n}{a^{n+2}[n\varepsilon_1+(n+1)\varepsilon_2]}P_n(\cos\theta)$$

16. 设介质球的半径为 a，

$r<a$，$$\phi_1=\frac{1}{4\pi\varepsilon_1}\left[\frac{\boldsymbol{p}_f\cdot\boldsymbol{r}}{r^3}+\frac{\boldsymbol{p}_f\cdot\boldsymbol{r}}{a^3}\frac{2(\varepsilon_1-\varepsilon_2)}{2\varepsilon_2+\varepsilon_1)}\right]$$

$r>a$，$$\phi_2=\frac{3\boldsymbol{p}_f\cdot\boldsymbol{r}}{4\pi(2\varepsilon_2+\varepsilon_1)r^3}$$

∵均匀介质：$\rho_P=0$，

$r\to 0$ 附近：极化偶极子：$\boldsymbol{P}=\left(\dfrac{\varepsilon_0}{\varepsilon_1}-1\right)\boldsymbol{P}_f$

$r=a$ 面上：$\sigma_P=\dfrac{3(\varepsilon_1-\varepsilon_2)\varepsilon_0 P_f}{2\pi\varepsilon_1(\varepsilon_1+2\varepsilon_2)a^3}\cos\theta$

17. $\phi=V-\boldsymbol{E}_0\cdot\boldsymbol{R}+\dfrac{a^3}{R^3}\boldsymbol{E}_0\cdot\boldsymbol{R}$

$\boldsymbol{E}=\boldsymbol{E}_0+a^3\left[\dfrac{3(\boldsymbol{E}_0\cdot\boldsymbol{R})\boldsymbol{R}}{R^5}-\dfrac{\boldsymbol{E}_0}{R^3}\right]$

$\sigma=3\varepsilon_0\boldsymbol{E}_0\cos\theta$

18. $\phi=\dfrac{\eta}{4\pi\varepsilon_0}\ln\dfrac{(x-c)^2+y^2}{(x+c)^2+y^2}$　其中：$c=\dfrac{b^2-a^2}{2b}$

19. $u=\dfrac{-q^2a}{8\pi\varepsilon(d^2-a^2)}$，$F=\dfrac{-q^2ad}{4\pi\varepsilon(d^2-a^2)^2}$

20. $h=\dfrac{1}{2}(\varepsilon-\varepsilon_0)\dfrac{V^2}{\tau g d^2}$

21. $Q=2(\varepsilon+\varepsilon_0)R\sqrt{\dfrac{2\pi mg}{(\varepsilon-\varepsilon_0)}}$

22. (1)$\boldsymbol{F}=\dfrac{3P^2\boldsymbol{R}}{4\pi\varepsilon_0R^5}$，　$W=\dfrac{P^2}{4\pi\varepsilon_0R^3}$　(2)$\boldsymbol{F}=-\dfrac{3P^2\boldsymbol{R}}{2\pi\varepsilon_0R^5}$，　$W=\dfrac{-P^2}{2\pi\varepsilon_0R^3}$

23. $\boldsymbol{F}=-\dfrac{3P^2(1+\cos^2\alpha)}{64\pi\varepsilon_0a^4}\boldsymbol{R}_0$

24. $\mathscr{D}_{11}=\mathscr{D}_{22}=\mathscr{D}_{33}=0$，$\mathscr{D}_{12}=\mathscr{D}_{21}=-3l^2Q$，　$\mathscr{D}_{23}=\mathscr{D}_{32}=0=\mathscr{D}_{13}=\mathscr{D}_{31}$

$\phi=-\dfrac{3Ql^2xy}{4\pi\varepsilon_0R^5}$，其中 $R=\sqrt{x^2+y^2+z^2}$

思考题与习题四

9. 六个象，三个正象位置分别为：$(-x_0,y_0,z_0)$，$(x_0,-y_0,z_0)$，$(-x_0,-y_0,z_0)$

三个负象位置分别为：$(-x_0,y_0,-z_0)$，$(x_0,-y_0,-z_0)$，$(-x_0,-y_0,-z_0)$

$$\phi=\frac{I}{4\pi\sigma}\left[\frac{1}{\sqrt{(x-x_0)^2+(y-y_0)^2+(z-z_0)^2}}+\frac{1}{\sqrt{(x+x_0)^2+(y-y_0)^2+(z-z_0)^2}}\right.$$
$$+\frac{1}{\sqrt{(x-x_0)^2+(y+y_0)^2+(z-z_0)^2}}+\frac{1}{\sqrt{(x+x_0)^2+(y+y_0)^2+(z-z_0)^2}}$$
$$-\frac{1}{\sqrt{(x-x_0)^2+(y-y_0)^2+(z+z_0)^2}}-\frac{1}{\sqrt{(x+x_0)^2+(y-y_0)^2+(z+z_0)^2}}$$
$$\left.-\frac{1}{\sqrt{(x-x_0)^2+(y+y_0)^2+(z+z_0)^2}}-\frac{1}{\sqrt{(x+x_0)^2+(y+y_0)^2+(z+z_0)^2}}\right]$$

10. $\boldsymbol{J}_1=\dfrac{3\sigma_1}{\sigma_1+2\sigma_2}\boldsymbol{J}_f$，$\boldsymbol{J}_2=\boldsymbol{J}_f+\dfrac{(\sigma_1-\sigma_2)}{\sigma_1+2\sigma_2}R_1^3\left[\dfrac{3(\boldsymbol{J}_f\cdot R)\boldsymbol{R}}{R^5}-\dfrac{\boldsymbol{J}_f}{R^3}\right]$

设：$\varepsilon_1\approx\varepsilon_2\approx\varepsilon_0$，

$\delta=\left(\varepsilon_1-\varepsilon_2\dfrac{\sigma_1}{\sigma_2}\right)\dfrac{\partial\phi_1}{\partial R}=\dfrac{3(\sigma_1-\sigma_2)\varepsilon_0}{\sigma_2(\sigma_1+2\sigma_2)}\boldsymbol{J}_f\cos\theta$

11. $m=\dfrac{Q\omega}{5}a^2$，$l=\dfrac{2}{5}M\omega a^2$，$m/l=Q/2M$

12. $\boldsymbol{B}_1=\dfrac{\mu_0\omega Q}{6\pi a}\boldsymbol{e}_z$，　$\boldsymbol{B}_2=\dfrac{\mu_0}{4\pi}\left[\dfrac{3(\boldsymbol{m}\cdot\boldsymbol{R})\boldsymbol{R}}{R^5}-\dfrac{\boldsymbol{m}}{R^3}\right]$，　$\boldsymbol{m}=\dfrac{Qa^2}{3}\boldsymbol{\omega}$

13. $R<a$，　$\boldsymbol{B}_1=\dfrac{3\mu_0\mu}{2\mu_0+\mu}\boldsymbol{H}_0+\dfrac{2\mu_0^2}{2\mu_0+\mu}\boldsymbol{M}_0$

$R>a$，　$\boldsymbol{B}_2=\mu_0\left[\boldsymbol{H}_0+\dfrac{3(\boldsymbol{m}\cdot\boldsymbol{R})\boldsymbol{R}}{R^5}-\dfrac{\boldsymbol{m}}{R^3}\right]$

其中：$\boldsymbol{m}=\dfrac{(\mu-\mu_0)\boldsymbol{H}_0+\boldsymbol{M}_0\mu_0}{2\mu_0+\mu}a^3$

15. $\boldsymbol{F}=-\dfrac{3\mu_0 m^2\boldsymbol{r}}{4\pi r^5}$

16. 矩形线圈四边受力分别为：

$F_{上}=-F_{下}=\dfrac{\mu_0 I_1 I_2}{2\pi}\ln\dfrac{a(d-b)}{b(d-a)}$

$F_{左}=\dfrac{\mu_0 I_1 I_2 c}{2\pi}\left[\dfrac{1}{a}+\dfrac{1}{d-a}\right]$

$F_{右}=\dfrac{-\mu_0 I_1 I_2 c}{2\pi}\left[\dfrac{1}{b}+\dfrac{1}{d-b}\right]$

思考题与习题五

7. 提示：直角坐标基矢与球坐标基矢变换关系为：

$$\begin{pmatrix}\boldsymbol{e}_x\\ \boldsymbol{e}_y\\ \boldsymbol{e}_z\end{pmatrix}=\begin{pmatrix}\sin\theta\cos\varphi & \cos\theta\cos\varphi & -\sin\varphi\\ \sin\theta\sin\varphi & \cos\theta\sin\varphi & \cos\varphi\\ \cos\theta & -\sin\theta & 0\end{pmatrix}\begin{pmatrix}\boldsymbol{e}_R\\ \boldsymbol{e}_\theta\\ \boldsymbol{e}_\varphi\end{pmatrix}$$

设：$\boldsymbol{P}_1=Pe^{-i\omega t}\boldsymbol{e}_x$，　$\boldsymbol{P}_2=Pe^{-i\left(\omega t-\frac{\pi}{2}\right)}\boldsymbol{e}_y$

$\boldsymbol{B}=\dfrac{\mu_0\omega^2 P}{4\pi CR}(\cos\theta\boldsymbol{e}_\varphi-i\boldsymbol{e}_\theta)e^{-i(\omega t-kR-\varphi)}$

$\boldsymbol{E}=\dfrac{\mu_0\omega^2 P}{4\pi R}(\cos\theta\boldsymbol{e}_\theta+i\boldsymbol{e}_\varphi)e^{-i(\omega t-kR-\varphi)}$

$\boldsymbol{S}=\dfrac{\mu_0\omega^4 P^2}{32\pi^2 CR^2}(\cos^2\theta+1)\boldsymbol{e}_R$

8. $\boldsymbol{B}=\dfrac{ea^2\omega^3 e^{i\left(kR+\frac{\pi}{2}\right)}}{8\pi\varepsilon_0 RC^4}\sin2\theta e^{-\frac{i}{2}\omega t}\boldsymbol{e}_\varphi$

$\boldsymbol{E}=2C\boldsymbol{B}\times\boldsymbol{e}_R$

$\boldsymbol{S}=\dfrac{1}{2}R_e(\boldsymbol{E}^*\times\boldsymbol{H})$

9. $\boldsymbol{B}=\dfrac{\omega^3 a^2 Qe^{ikR}}{\pi\varepsilon_0 C^4 R}\left[\dfrac{1}{2}\sin2\theta\sin(2\omega t-2\varphi)\boldsymbol{e}_\varphi+\sin\theta\cos(2\omega t-2\varphi)\boldsymbol{e}_\theta\right]$

$\boldsymbol{E}=C\boldsymbol{B}\times\boldsymbol{e}_R$

$\overline{\boldsymbol{S}}=\dfrac{1}{2}R_e(\boldsymbol{E}^*\times\boldsymbol{H})$

10. $\because l\ll\lambda$，$\therefore$可视作短天线为电偶极辐射.

$\dot{P}=\dfrac{1}{2}I_0 le^{-i\omega t}$

$\therefore\boldsymbol{B}=\dfrac{-i\omega I_0 l\sin\theta}{4\pi\varepsilon_0 C^3 R}e^{ikR}\boldsymbol{e}_\varphi$

$\boldsymbol{E}=C\boldsymbol{B}\times\boldsymbol{e}_R$

$\overline{\boldsymbol{S}}=\dfrac{1}{2}R_e(\boldsymbol{E}^*\times\boldsymbol{H})$

11. 提示：电荷 e 绕原点以角速度 ω 旋转，可分解为相互成直角、位相差 $\frac{\pi}{2}$ 有同一频率的简谐振动的辐射.

$\boldsymbol{P}_1=eae^{-i\omega t}\boldsymbol{e}_x$，　　$\boldsymbol{P}_2=eae^{-i\left(\omega t-\frac{\pi}{2}\right)}\boldsymbol{e}_y$

$\boldsymbol{B}=\frac{\mu_0 ea\omega^2}{4\pi CR}\cdot(\cos\theta\boldsymbol{e}_\varphi-i\boldsymbol{e}_\theta)e^{-i(\omega t-kR-\varphi)}$

$\boldsymbol{E}=C\boldsymbol{B}\times\boldsymbol{e}_R$，　　$\overline{S}=\frac{1}{2}R_e(\boldsymbol{E}^*\times\boldsymbol{H})$，　　$P=\oint_S\overline{S}\cdot dS$

12. 提示：参看书中(4.21)式

$|\boldsymbol{E}|\approx 3.14\times10^{-2}(\mathrm{V/m})$

13. $\boldsymbol{B}=\frac{\mu_0 a^3\omega^2 M}{3C^2R}\sin\Phi e^{ikR}[\cos\theta\boldsymbol{e}_\theta+i\boldsymbol{e}_\varphi]e^{i\varphi}$

$\boldsymbol{E}=C\boldsymbol{B}\times\boldsymbol{e}_R$

$\overline{S}=\frac{1}{2}R_e(\boldsymbol{E}^*\times\boldsymbol{H})$

思考题与习题六

10. $W=3.927\times10^{26}\mathrm{W}$

$E_{太}=2.196\times10^5\mathrm{V/m}$

14. $0.336\times10^2\mathrm{m}$，$0.237\mathrm{m}$，$0.116\times10^{-1}\mathrm{m}$

15. $\boldsymbol{E}_g=\boldsymbol{E}_{g_0}e^{-i\left(\omega t-k_z z+\frac{\pi}{2}\right)}$，$E_{g_0}=80\mathrm{V/m}$，$\omega=2\pi f$

16. $\alpha_a=\frac{Vk_z}{a\omega\mu\ln b/a}e^{-i(\omega t-k_z z)}$，　$\alpha_b=\frac{-Vk_z}{b\omega\mu\ln b/a}e^{-i(\omega t-k_z z)}$，　$P=\frac{\pi V^2k_z}{\omega\mu\ln b/a}$

17. $E_x=\frac{ik_xk_z}{k^2-k_z^2}A\cos k_x x\sin k_y y\cdot e^{ik_z z}$

$E_y=\frac{ik_yk_z}{k^2-k_z^2}A\sin k_x x\cos k_y y\cdot e^{ik_z z}$

$E_y=A\sin k_x x\sin k_y y\cdot e^{ik_z z}$

$H_x=\frac{-i\omega\varepsilon k_y}{k^2-k_z^2}A\sin k_x x\cos k_y y\cdot e^{ik_z z}$

$H_y=\frac{i\omega\varepsilon k_x}{k^2-k_z^2}A\cos k_x x\sin k_y y\cdot e^{ik_z z}$

$H_z=0$

其中：$k_x=\frac{m\pi}{a}$，　　$k_y=\frac{n\pi}{b}$，　　$m,n=1,2,3,\cdots$

19. $F_e=\frac{Wr^2}{2CR^2}$，　　$F_g=G\frac{m_1m_2}{R^2}$，　　$r\approx0.23\times10^{-6}\mathrm{m}$

思考题与习题七

7. $l=\frac{1-\beta^2}{1+\beta^2}l_0$，　　$\beta=\frac{v}{c}$

9. (1)12：50　(2)7.2×10^{11}米　(3)13：30　(4)16：30′

10. (1)$\Delta t=\frac{1+\frac{v}{cn}}{v+\frac{c}{n}}l_0$　(2)$\Delta t=l_0\sqrt{\frac{1-\beta^2}{\left(\frac{c}{n}\right)^2-v^2}}$

12. (1)$h\gamma'=4.688\times10^4ev$　(2)$h\gamma''=1.099\times10^9ev$

15. (1)144.7Mev　(2)279.7Mev

16. $\boldsymbol{F}'=\gamma\boldsymbol{F}=\dfrac{1}{\sqrt{1-\beta^2}}\cdot\dfrac{mv^2}{R}\boldsymbol{e}_R$

17. $\boldsymbol{F}=\dfrac{q\eta}{2\pi\varepsilon_0 r}\sqrt{1-\beta^2}\boldsymbol{e}_r$

18. $\left(x^2-\dfrac{v_0}{\omega_0}\right)^2+y^2=\left(\dfrac{v_0}{\omega_0}\right)^2$,　　$\omega_0=\dfrac{e}{m}B$

19. (1)$\dfrac{7}{12}m_0c$　(2)$0.2m_0c$　(3)$\dfrac{35}{12}m_0c^2$　(4)$M_0=\dfrac{7}{\sqrt{6}}m_0$　(5)$\dfrac{35-14\sqrt{6}}{12}m_0c^2$

20. $\dfrac{c^2}{2m_\pi}(m_\pi^2-m_\mu^2)$,　　$\dfrac{c^2}{2m_\pi}(m_\pi-m_\mu)^2$

21. (1)B 收到：$\dfrac{l}{v}f'\sqrt{\dfrac{1-\beta}{1+\beta}}$,　　A 收到：$\dfrac{l}{v}f'(1-\beta)$

(2)A 收到：$2\dfrac{l}{v}f'$,　　B 收到：$2\dfrac{l}{c}f'\sqrt{1-\beta^2}$

(3)A、B 共同认为 A 年轻了，$\dfrac{2l}{v}f'>\dfrac{2l}{v}f'\sqrt{1-\beta^2}$

思考题与习题八

8. $\dfrac{\mathrm{d}P}{\mathrm{d}\Omega}=\dfrac{e^2}{16\pi^2\varepsilon_0C^3}\dot{v}^2\sin^2\theta$

9. $\dfrac{e^2\dot{\boldsymbol{v}}}{6\pi\varepsilon_0C^3}$,　　10^{-11}s

10. (1) $\left[X-\left(R_0+\dfrac{v_0}{\omega_0}\right)\right]^2+y^2=\left(\dfrac{v_0}{\omega_0}\right)^2e^{-2\gamma t}$

其中：$\omega_0=\dfrac{eB}{m}$,　　$\gamma=\dfrac{e^2\omega_0^2}{6\pi\varepsilon_0C^3m}$

(2)$P\approx\dfrac{e^2\omega_0^2v_0^2}{6\pi\varepsilon_0C^3}e^{-2\gamma t}$