P252. 19-2

(1) $483 \cdot 6000 = 488 \cdot T' \Rightarrow T' = 5938.5\,K$

(2) $\Delta E = \sigma(T^4 - T'^4)$. $E = \sigma T^4 \Rightarrow \frac{\Delta E}{E} = 1 - (\frac{T'}{T})^4 = 0.04$

P253. 19-4

(1) $P_E \frac{1}{4\pi R_{SE}^2} = P \Rightarrow P = 4\pi P R_{SE}^2$

(2) $M = \frac{P_E}{4\pi R_s^2} = P\frac{R_{SE}^2}{R_s^2} = \sigma T^4 \Rightarrow T = (\frac{P R_{SE}^2}{\sigma R_s^2})^{\frac{1}{4}}$

P253. 19-8

$M_1 = \sigma T_1^4$, $M_3 = \sigma T_3^4$ $M_2 = \sigma T_2^4$ 令 $T_1 > T_3$

2板左侧 $P_1 = M_1 - M_2 = \sigma(T_1^4 - T_2^4)$ 吸

2板右侧 $P_2 = M_2 - M_3 = \sigma(T_2^4 - T_3^4)$ 放.

∴ $P_1 = P_2 \Rightarrow \sigma\, T_1^4 - T_2^4 = T_2^4 - T_3^4 \Rightarrow 2T_2^4 = T_1^4 + T_3^4$

∴ $T_2 = [\frac{1}{2}(T_1^4 + T_3^4)]^{\frac{1}{4}}$

P253. 19-10

$M(\lambda, T) = 2\pi h c^2 \lambda^{-5} \frac{1}{e^{hc/k_B T\lambda} - 1}$. $P = \int_{\lambda_0}^{\lambda_0 + d\lambda} M(\lambda, T) d\lambda \cdot S$

$P_0 = \sigma T^4 S \Rightarrow S = \frac{P_0}{\sigma T^4}$ $= \int M(\lambda_0, T) \cdot d\lambda = nh\frac{c}{\lambda_0}$

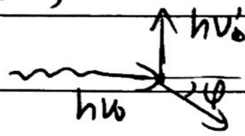
∴ $\frac{2\pi h c^2 \lambda_0^{-5} S}{e^{hc/k_B T\lambda_0} - 1} \cdot d\lambda = nh\frac{c}{\lambda_0} \Rightarrow n = 5.7 \times 10^{13}$

P253. 19-13

(1) $\Delta\lambda = \lambda_c \cdot (1-\cos\theta) = \lambda_c = 2.43\times10^{-12}\,m = 0.00243\,nm$

$\therefore\ \lambda' = \Delta\lambda + \lambda_0 = 0.1 + 0.00243 = 0.10243\,nm.$

(2) $h\nu_0 + m_e c^2 = h\nu_1 + m_e' c^2$, $m_e' = \frac{m_e}{\sqrt{1-\frac{u^2}{c^2}}}$, $\nu = \frac{c}{\lambda}$.



$p = \frac{h}{\lambda} \Rightarrow \frac{h}{\lambda'} = m_e' u \sin\varphi = p_e \sin\varphi$

$\frac{h}{\lambda} = \cancel{\frac{h}{\lambda}}\ \cancel{m}\ p_e \cos\varphi \Rightarrow p_e^2 = \frac{h^2}{\lambda'^2} + \frac{h^2}{\lambda_0^2} \Rightarrow p_e = 9.26\times10^{-24}$ kg·m/s

$\therefore\ \sin\varphi = \frac{h}{\lambda' p_e} = 0.699 \Rightarrow \varphi = 44.36^\circ$. $\cancel{E_k = h(\nu_0-\nu_1) =}$

$E_k = h(\nu_0-\nu_1) = hc\left(\frac{1}{\lambda_0} - \frac{1}{\lambda'}\right) = 291\,eV$

P253. 19-14

$h\nu_0 = E_0 \Rightarrow \nu_0 = \frac{E_0}{h} = \frac{c}{\lambda_0} \Rightarrow \lambda_0 = \frac{hc}{E_0}$

$\lambda' = 1.2\lambda_0$. $E_k = h\nu_0 - h\nu_1 = h\nu_0 - h\frac{c}{1.2\lambda_0} = hc\left(\frac{1}{\lambda_0} - \frac{5}{\lambda_0\cdot 6}\right)$

$= hc\frac{1}{6\lambda_0} = \frac{1}{6}h\nu_0 = 0.10\,MeV$

P254. 19-18.

$L = n\hbar = mu\cdot R$, $m\frac{u^2}{R} = quB \Rightarrow R^2 = \frac{n\hbar}{qB}$

$\therefore\ r_n = \frac{n\hbar}{qB}$, $n=1,2,3,\cdots$, $\cancel{E_k = (m-m')c^2 = m\left(1-\frac{1}{\sqrt{1-\frac{n^2\hbar^2}{m^2}}}\right)}$

$E_k = m\left(1-\frac{1}{\sqrt{1-\frac{u^2}{c^2}}}\right)c^2$, $u = \frac{\sqrt{qBn\hbar}}{m}$

$\Rightarrow E_k = mc^2\left(1-\frac{1}{\sqrt{1-\frac{qB\hbar n}{m^2c^2}}}\right)$ $n=1,2,3,\cdots$

P254. 19-3.

$\lambda_m \cdot T \equiv const.$ $\therefore \lambda_2 < \lambda_1$. $M = \sigma T^4$ $\therefore M_2 > M_1$

$\therefore$ D

P255. 19-7

$h\nu = \frac{1}{2} m v_m^2 + A$ $\quad U_a e = \frac{1}{2} m v_m^2 \Rightarrow h\nu = U_a e + A$

$\Rightarrow U_a = \frac{h}{e}\nu - \frac{A}{e}$ $\quad A_2 > A_1 \therefore$ B

P255 19-8

$h\nu_1 - A_1 = E_1,\ h\nu_2 - A_2 = E_2,\ E_1 > E_2 \Rightarrow h\nu_1 - A_1 > h\nu_2 - A_2$

$\therefore \nu_1 > \nu_2 + (A_1 - A_2)$ $\quad$ D

P255. 19-9

$U_a = \frac{h}{e}\nu - \frac{A}{e}$ $\quad h\nu_0 = A \Rightarrow U_a = \frac{h}{e}\nu - \frac{h}{e}\nu_0 = \frac{h}{e}(\nu - \nu_0)$

$\therefore \nu_2 - \nu_0 = 2(\nu_1 - \nu_0) \Rightarrow \nu_2 = 2\nu_1 - \nu_0$, C

P255. 19-11

$I \propto n$ $\therefore$ D

P255. 19-12.

$A = h\frac{c}{\lambda}$. $h\nu = \frac{1}{2} m v_m^2 + A$, $\frac{m v_m^2}{R} = Bev \Rightarrow v_m = \frac{RBe}{m}$

$\therefore E = h\nu = \frac{1}{2} m \left(\frac{RBe}{m}\right)^2 + h\frac{c}{\lambda} = \frac{R^2 B^2 e^2}{2m} + h\frac{c}{\lambda}$. $\therefore$ B

P292. 20-9

$\Delta x = 0.1\text{Å} = 0.01\text{nm}$. $\Delta x \Delta p \geq \frac{\hbar}{2}$ => $\Delta p \geq \frac{\hbar}{2\Delta x} = 5.27\times10^{-24}$ kgm/s

$\Delta x \cdot \Delta p \approx h \Rightarrow \Delta p \approx \frac{h}{\Delta x} = 6.63\times10^{-23}$ kg m/s

$\Delta E = \Delta(\frac{\Delta p^2}{2m}) = \frac{p\Delta p}{m} = (\frac{2E_k}{m})^{\frac{1}{2}}\Delta p = 1.24\times10^{-18}$ J

P292. 20-11

$\Delta\lambda = 10^{-9}\text{nm} = 10^{-18}\text{m}$. $\lambda = 434.05\text{nm} = 4.3405\times10^{-7}$ m.

$\Delta p = \frac{h}{\lambda^2}\Delta\lambda$, $\Delta E = \Delta p \cdot c = \frac{hc}{\lambda^2}\Delta\lambda$

$\Delta E \cdot \Delta t \geq \frac{h}{4\pi} \Rightarrow \Delta t \geq \frac{h}{4\pi}\cdot\frac{\lambda^2}{hc\Delta\lambda} = \frac{\lambda^2}{4\pi c\Delta\lambda} = 5\times10^{-11}$ s

P292. 20-13

处于基态时，有 $mur = \hbar$, $m\frac{u^2}{r} = \frac{e^2}{4\pi\varepsilon_0 r^2} \Rightarrow r = \frac{\varepsilon_0 h^2}{\pi m e^2}$

$E = E_k + E_u = \frac{1}{2}mu^2 - \frac{e^2}{4\pi\varepsilon_0 r} = -\frac{e^2}{8\pi\varepsilon_0 r} = \frac{-me^4}{8\varepsilon_0^2 h^2} = -13.6\text{eV}$

$E = \frac{p^2}{2m} - \frac{e^2}{4\pi\varepsilon_0 r}$. $\Delta p \cdot \Delta r \approx h \Rightarrow$ ~~$p \approx \frac{h}{r}$~~ ? $p \approx \frac{h}{r}$. $p \geq \frac{\hbar}{2r}$

~~$E \approx \frac{h^2}{2mr^2} - \frac{e^2}{4\pi\varepsilon_0 r} = \frac{h^2}{2m}\frac{\pi^2 m^2 e^4}{\varepsilon_0^2 h^4} - \frac{e^2}{4\pi\varepsilon_0}\frac{\pi m e^2}{\varepsilon_0 h^2}$~~ $p = \frac{\hbar}{r}$

~~$= \frac{\pi^2 m e^4}{2\varepsilon_0^2 h^2} - \frac{me^4}{4\varepsilon_0^2 h^2}$~~ $E = \frac{p^2}{2m} - \frac{e^2}{4\pi\varepsilon_0 r} = \frac{p^2}{2m} - \frac{e^2 p}{4\pi\varepsilon_0\hbar}$

$E_{min} = -\frac{me^4}{8\varepsilon_0^2 h^2} = -13.6\text{eV}$.

粒子流守恒定律.

$\frac{\partial}{\partial t}\iiint_\Omega \rho\, dV = \iiint \frac{\partial\rho}{\partial t} dV$. $\rho = \Psi(x,t)\Psi^*(x,t)$, $\frac{\partial\rho}{\partial t} = \Psi\frac{\partial\Psi^*}{\partial t} + \Psi^*\frac{\partial\Psi}{\partial t}$.

$i\hbar\frac{\partial}{\partial t}\Psi = E\Psi = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}\Psi + U\Psi$

$\Rightarrow \frac{\partial}{\partial t}\Psi = i\frac{\hbar}{2m}\nabla^2\Psi + \frac{U}{i\hbar}\Psi$, $\frac{\hbar}{2m}\nabla^2\Psi$, $\frac{U}{\hbar}\Psi$ 均为实数.

$\therefore \frac{\partial}{\partial t}\Psi^* = -i\frac{\hbar}{2m}\nabla^2\Psi^* - \frac{U}{i\hbar}\Psi^* \Rightarrow \frac{\partial\rho}{\partial t} = i\frac{\hbar}{2m}[(\nabla^2\Psi)\Psi^* - (\nabla^2\Psi^*)\Psi]$

记 $-i\frac{\hbar}{2m}(\Psi^*\nabla\Psi - \Psi\nabla\Psi^*) = j$ $= i\frac{\hbar}{2m}\nabla(\Psi^*\nabla\Psi - \Psi\nabla\Psi^*)$

$\therefore \frac{\partial\rho}{\partial t} = -\nabla j \Rightarrow \iiint_\Omega \frac{\partial\rho}{\partial t} dV = -\oiint_S \vec{j}\, d\vec{S}$. 若全空间边界|Ψ|=0, 则得证.

~~波函数~~ 四处处