Problem Set 2.

4.50. (a). $W_0 = h\frac{c}{\lambda_0} \approx 6.306\times10^{-4}\,J$

$= 3.936\ eV.$

(b). $E_K = h\frac{c}{\lambda_1} - W_0$

$= hc\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_0}\right) = 2.263\ eV$

(c). $\because E_K \ll m_e c^2$

$\therefore p_e = \sqrt{2m_e E_K}.$

$\lambda = \frac{h}{p_e} = \frac{h}{\sqrt{2m_e E_K}} = 8.15\times10^{-10}\ m$

4.52 $\begin{cases} r_e m_e v = n\frac{h}{2\pi} \\ m_e\frac{v^2}{r_e} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{Ze^2}{r_e^2} \end{cases}$

$\therefore v_e = \frac{Ze^2}{2\varepsilon_0 nh}$

对 $He^+$: $Z = 2$.

$v_e(He^+) = 4.375\times10^6\ m\cdot s^{-1}$

对 $U^{91+}$: $Z = 91$

$v_e(U^{91+}) = 1.991\times10^8\ m\cdot s^{-1}$

对核电荷数越大的离子，相对论效应越显著

3.(a). $\because \frac{1}{\lambda} = R\left(\frac{1}{n^2} - \frac{1}{n'^2}\right)$

对于类似氢原子的模型

$$R = \frac{m_e Z^2 e^4}{8\varepsilon_0^2 h^3 c}.$$

$$\therefore \frac{1}{\lambda} = \frac{3}{4}R = \frac{3}{32} \cdot \frac{m_e Z^2 e^4}{\varepsilon_0^2 h^3 c}.$$

$$\therefore \lambda = \frac{32\varepsilon_0^2 h^3 c}{3 m_e Z^2 e^4}.$$

(b). $\frac{32\varepsilon_0^2 h^3 c}{3 m_e (Z-1)^2 e^4} = 1.54\text{Å}$

$$Z - 1 \approx 28$$

$$Z = 29$$

$\therefore$ Z 是铜

5.46

(a). $\psi(0) = \left(\frac{1}{\pi a_0^3}\right)^{\frac{1}{2}}$

$$P = |\psi(0)|^2 \Delta V$$

$$= \frac{1}{\pi a_0^3} \Delta V = 2.150 \times 10^{-6}$$

(b). $\psi(r_0) = \left(\frac{1}{\pi a_0^3}\right)^{\frac{1}{2}} \cdot e^{-1}$

$$P = |\psi(r_0)|^2 \Delta V = 2.910 \times 10^{-7}$$