CHAPTER 6: (Thornton and Rex Chap 4)STRUCTURE OF ATOMS

SOLUTIONS (Due Oct 29, 12)

10. From the Rutherford scattering result, the number detected through a small angle is inversely proportional to $\sin^4\left(\frac{\theta}{2}\right)$. Thus $\frac{n(50^\circ)}{n(6^\circ)} = \frac{\sin^4(3^\circ)}{\sin^4(25^\circ)} = 2.35\times10^{-4}$ and if they count 2000 at $6°$ the number counted at $50°$ will be $(2000)(2.35\times10^{-4}) = 0.47$ which is insufficient.

14. (a) $v = \frac{e}{\sqrt{4\pi\epsilon_0 mr}} = \frac{ec}{\sqrt{4\pi\epsilon_0 mc^2 r}} = \frac{\sqrt{1.44\text{ eV}\cdot\text{nm}}}{\sqrt{(511000\text{ eV})(1.2\times10^{-6}\text{ nm})}}c = 1.53c$

which is not an allowed speed.

(b) $E = -\frac{e^2}{8\pi\epsilon_0 r} = -\frac{1.44\text{ eV}\cdot\text{nm}}{2(1.2\times10^{-6}\text{ nm})} = -600\text{ keV}$

(c) Clearly (a) is not allowed and (b) is too much energy.

20. (a) As in Problem 16, $v = 2.19\times10^6$ m/s and

$L = mvr = (9.11\times10^{-31}\text{ kg})(2.19\times10^6\text{ m/s})(5.29\times10^{-11}\text{ m}) = 1.0554\times10^{-34}\text{ kg}\cdot\text{m}^2/\text{s}$

Notice that $L = \hbar$.

(b) Using Equation (4.31) for v and Equation (4.24) for r_n we find

$L = mv_2r_2 = m\left(\frac{1}{n}\frac{\hbar}{ma_0}\right)(n^2a_0) = n\hbar = 2\hbar$ as expected.

32. The reduced mass for this system is $\mu = \frac{mm}{m+m} = m/2$ where m is the mass of each particle. Then $r = \frac{4\pi\epsilon_0\hbar^2}{\mu e^2} = 2a_0$ and $E = -\frac{e^2}{8\pi\epsilon_0 r} = -\frac{e^2}{8\pi\epsilon_0(2a_0)} = -\frac{E_0}{2} = -6.8\text{ eV}$.