PROBLEM 1

IF $\lambda_{limit} = 91.13nm$, THEN THE FIRST THREE (LONGEST) WAVELENGTHS IN THE LYMAN SERIES BECOME

$$\lambda_2 = 91.19nm\left(\frac{2^2}{2^2-1}\right) = 121.58nm$$

$$\lambda_3 = 91.19nm\left(\frac{3^2}{3^2-1}\right) = 101.59nm$$

$$\lambda_4 = 91.19nm\left(\frac{4^2}{4^2-1}\right) = 97.27 nm$$

Equation 6.21

Problem 2

For a Bohr model of hydrogen in the $n=3$ state the orbiting radius is calculated as follows:

Equation 6.29

$$r_3 = \frac{4\pi\varepsilon_0 \hbar^2}{me^2} \cdot 3^2 = 0.0529\,nm \cdot 3^2 = 0.4761\,nm$$

Equation 6.26 gives velocity of an electron in a circular orbit as

$$v = \frac{n\hbar}{m_e r} = \frac{3\hbar}{m_e(0.4761\,nm)} = \boxed{7.295 \cdot 10^5\ m\,s^{-1}}$$

$$\Rightarrow KE = \frac{1}{2} m_e v^2 = \frac{1}{2}\left(\frac{511{,}000\,eV}{(2.998 \cdot 10^8\,m\,s^{-1})^2}\right)(7.295 \cdot 10^5\,m\,s^{-1})^2$$

$$= \boxed{1.51\,eV.}$$

$U_0 = E_3 - KE$ where E_3 is calculated with equation 6.30 as follows:

$$E_3 = \frac{-13.60\,eV}{3^2} = -1.51\,eV \Rightarrow U_0 = -1.51\,eV - 1.51\,eV = \boxed{3.02\,eV.}$$

PROBLEM 3

ASSUMING THAT THE ELECTRON IS RELAXING, THE AVAILABLE TRANSITIONS, AND THE ASSOCIATED ENERGY CHANGES, ARE AS FOLLOWS:

$$E_5 - E_1 = \frac{-13.60\,eV}{5^2} - \frac{-13.60\,eV}{1^2} = \underline{13.056\,eV}$$

$$E_5 - E_2 = \frac{-13.6\,eV}{5^2} - \frac{-13.6\,eV}{2^2} = \underline{2.856\,eV}$$

$$E_5 - E_3 = \underline{0.967\,eV}$$

$$E_5 - E_4 = \underline{0.306\,eV}.$$

PROBLEM 4

THE ATOM ABSORBED A PHOTON OF ENERGY $\lambda = 15\,nm \Rightarrow E_p = \frac{hc}{\lambda} = \frac{1240\,eV\cdot nm}{15\,nm} = 82.67\,eV$.

THIS IS FAR MORE THAN THE 13.6 eV NECESSARY TO IONIZE THE ATOM. THE ELECTRON SHOULD BE IMPARTED WITH $82.67\,eV - 13.6\,eV = \boxed{69.07\,eV}$. KINETIC ENERGY.

PROBLEM 5

THE BOHR MODEL APPLY'S TO ATOMS WITH ONE ELECTRON. HELIUM HAS 2 ELECTRONS.

PROBLEM 6

a.) FROM EQUATIONS 6.26 & 6.28 WE HAVE

$$v = \frac{n\hbar}{m r_n} \quad \& \quad r_n = \frac{4\pi \varepsilon_0 \hbar^2 n^2}{m_e e^2}$$

$$\Rightarrow v = \frac{\cancel{n}\hbar e^2 \cancel{m_e}}{\cancel{m_e} 4\pi \varepsilon_0 \hbar^2 n^{\cancel{2}}} = \frac{e^2}{4\pi\varepsilon_0} \cdot \frac{1}{\hbar n}$$

$$= \frac{e^2}{c 4\pi \varepsilon_0 \hbar} \cdot \frac{c}{n}.$$

IF $\alpha = \frac{e^2}{4\pi\varepsilon_0 \hbar c}$ WE HAVE

$$v = \alpha \cdot \frac{c}{n}$$

b.) IF THE PROTON HAD CHARGE Ze, FOR SOME POSITIVE INTEGER Z, INSTEAD OF JUST e, THE COULOMBIC ATTRACTION HAS $(Ze) \cdot e = Ze^2$ INSTEAD OF e^2 AND WE GET $\boxed{v = Z \cdot \alpha \cdot \frac{c}{n}}$.