HW 11/17

7.29) a) $n_i = 6$ $\quad E_{photon} = E_i - E_f = \frac{-13.6\,eV}{6^2} - \frac{-13.6\,eV}{3^2} = 1.13\,eV$

$n_f = 3$

b) $E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E} = \frac{1240\,eV \cdot nm}{1.13\,eV} = 1.1 \cdot 10^{-6}\,m$

$$\boxed{\lambda = 1.1 \cdot 10^{-6}\,m}$$

7.32) a) $\Delta E = E_4 - E_2 = (-13.6\,eV)\left(\frac{1}{4^2} - \frac{1}{2^2}\right) = 2.55\,eV$

$E = \frac{hc}{\lambda} \rightarrow 2.55\,eV = \frac{1240\,eV\,nm}{\lambda}$

$\hookrightarrow \boxed{\lambda = 486\,nm}$

b) Eq 7-13: $\frac{1}{\lambda} = 1.097 \cdot 10^7\,m^{-1}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

$n=4 \rightarrow n=3$: $\lambda = 1875$ nm

$4 \rightarrow 2$: $\lambda = 486$ nm

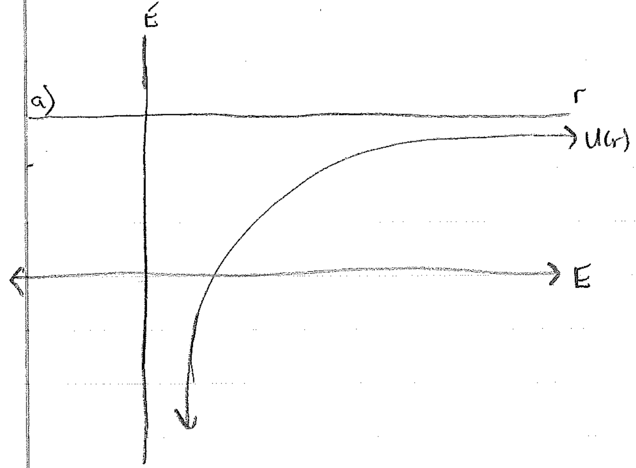
$4 \rightarrow 1$: $\lambda = 97.2$ nm

$3 \rightarrow 2$: $\lambda = 656$ nm

$3 \rightarrow 1$: $\lambda = 103$ nm

$2 \rightarrow 1$: $\lambda = 122$ nm

7.57) a)



b) Set the total energy equal to potential (KE=0).
For $n=1$:

$$E = \frac{me^4}{2(4\pi\varepsilon_0)^2\hbar^2}\cdot\frac{1}{1^2} = \frac{-1}{4\pi\varepsilon_0}\cdot\frac{e^2}{r} = U$$

$$\hookrightarrow \quad r = 2\,\frac{(4\pi\varepsilon_0)\hbar^2}{me^2} = 2a_0 \quad \checkmark$$

c) $P(r) = R^2 r^2 = \left(\frac{1}{(1a_0)^{3/2}}\cdot 2e^{-r/a_0}\right)^2 r^2 = \frac{4}{a_0^3} r^2 e^{-2r/a_0}$

$$\text{Probability} = \frac{4}{a_0^3}\int_{2a_0}^{\infty} r^2 e^{-2r/a_0}\,dr \qquad \begin{matrix} u = r^2 & v = \frac{-2}{a_0}e^{-2r/a_0} \\ du = 2r & dv = e^{-2r/a_0}\,dv \end{matrix}$$

$$= \frac{4}{a_0^3}\left(r^2\cdot\frac{-a_0}{2}e^{-2r/a_0} - \int_{2a_0}^{\infty} 2r\,\frac{-a_0}{2}e^{-2r/a_0}\,dr\right) \qquad \begin{matrix} u' = 2r & v' = \left(\frac{a_0}{12}\right)^2 e^{-2r/a_0} \\ du' = 2dr & dv' = \left(\frac{-a_0}{2}\right)e^{-2r/a_0}\,dr \end{matrix}$$

$$= \frac{4}{a_0^3}\left(r^2\left(\frac{-a_0}{2}\right)e^{-2r/a_0} - 2r\left(\frac{a_0}{2}\right)^2 e^{-2r/a_0} + \int_{2a_0}^{\infty} 2\left(\frac{2}{a_0}\right)^2 e^{-2r/a_0}\,dr\right)$$

$$= \frac{4}{a_0^3}\left(r^2\cdot\frac{-a_0}{2}e^{-2r/a_0} - 2r\left(\frac{-a_0}{2}\right)^2 e^{-2r/a_0} + 2\left(\frac{-a_0}{2}\right)^3 e^{-2r/a_0}\right)\Bigg|_{2a_0}^{\infty}$$

$$= \frac{4}{a_0^3}\left((2a_0)^2\cdot\frac{a_0}{2}e^{-4} + 2(2a_0)\left(\frac{a_0}{2}\right)^2 e^{-4} + 2\left(\frac{a_0}{2}\right)^3 e^{-4}\right) = 13e^{-4} = \boxed{0.238}$$

• This is a fairly high probability