Physics 197 Chapter #36
Homework Solutions

Problem #1 (P1E002): electron energy = −0.544eV

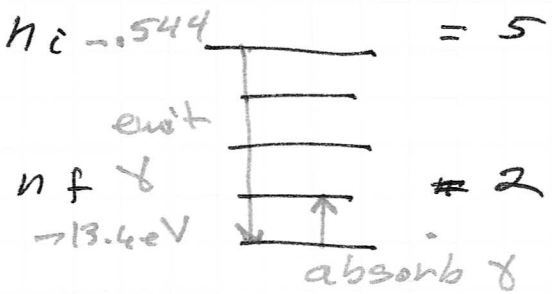
atom emits a photon, then absorbs a photon ending with an energy of −3.4eV. Determine λ of emitted photon.

$$E_i = -.544eV = \frac{-13.6eV}{n_i^2}$$

$$n_i = 5$$

$$E_f = -3.4eV = \frac{-13.6eV}{n_f^2}$$

$$n_f = 2$$



$$\Delta E = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{\Delta E} = \frac{1240eV \cdot nm}{-13.6eV + .544eV}$$

$$\lambda = \frac{1240eV \cdot nm}{13.056eV} = 95nm.$$

Problem #2 (P002): n=4, quintuply ionized Carbon (Z=6)

$$E_4 = -\frac{Z^2}{n^2}(13.6eV) = -\frac{Z^2}{n^2}E_0$$

$$E_4 = -\frac{(6)^2}{4^2}E_0 = \frac{-36}{16}E_0 = -2.25E_0$$

~~$E_4 = 1.5E_0$~~ $E_4 = -2.25E_0$

Problem #3 (P006): $n=1 \rightarrow a_0 = 0.053\,nm$.

$n=5 \rightarrow n^2 a_0 = 2540$

$r_5 = 2540$

Problem #4 (P028) Lyman Series ends at $n=1 = -13.6\,eV$

(a) $E_{n,\,n=5} = \frac{-13.6}{25} = -.544\,eV$

$\lambda = \frac{hc}{\Delta E} = \frac{1240\,eV\cdot nm}{13.6 - .544} = \frac{1240\,eV\cdot nm}{13.056\,eV}$

$\boxed{\lambda = 95\,nm}$

(b) $E_{n,\,n=6} = \frac{-13.6\,eV}{36} = -.378\,eV$

$\lambda = \frac{1240\,eV\cdot nm}{(13.6 - .378)\,eV} = $ ~~94 nm~~. $93.78\,nm$

$\boxed{\lambda = 93.78\,nm}$

Problem #5 (P25): Pfund Series end at $n=5$

(a) $E_5 = \frac{-13.4\,eV}{25} = -.544\,eV$

Shortest $\lambda \Rightarrow$ highest energy $\Rightarrow n = \infty$

~~$E_6 = \frac{-13.6\,eV}{36} = -.378\,eV$~~ $\Delta E = E_5 - 0$

$\boxed{\Delta E = -.544\,eV}$

~~$\Delta E = (.544 - .378)\,eV = .166$~~

$\boxed{\lambda = \frac{1240\,eV\cdot nm}{-.544\,eV} = 2279\,nm}$

(b) Longest $\lambda \Rightarrow$ lowest E, $\Rightarrow n = 6, 7, 8$

$E_6 = \frac{-13.6\,eV}{36} = .378\,eV$ $\quad \Delta E = .167\,eV$, $\boxed{\lambda = \frac{1240}{.167} = 7425}$

$E_7 = \frac{-13.6\,eV}{49} = -.278\,eV$ $\quad \lambda = \frac{1240}{.544 - .278} = \boxed{4661}$, $\quad E_8 = \frac{-13.6\,eV}{64} = -.2125\,eV$ $\quad \boxed{\lambda = 3741\,nm}$