Homework 11 -

Ch 28 : 2 8 10 20 28 32 34 36

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(2) Balmer eq^N : $\frac{1}{\lambda} = R_H\left(\frac{1}{2^2} - \frac{1}{n^2}\right) = R_H\left(\frac{n^2-4}{4n^2}\right)$

Balmer series //

$$\Rightarrow \quad \lambda = \frac{4}{R_H}\left(\frac{n^2}{n^2-4}\right) = \left(\frac{364.5\, n^2}{n^2-4}\right) \text{ nm} \quad //$$

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(8) H grand state $\Rightarrow \underline{n=1}$

$r_n = a_0 n^2 \Rightarrow r_1 = a_0 = 5.29\times10^{-11}\text{ m} = 0.529\text{ Å}$

$v_n = \frac{n\hbar}{m r_n} \Rightarrow v_1 = \frac{\hbar}{m a_0} = 2.16\times10^7 \frac{\text{m}}{\text{s}}$

$= 0.72c$

$KE_n = \frac{ke^2}{2r_n} = 13.6\text{eV}$ for $n=1$

$PE_1 = -\frac{ke^2}{r_1} = -2KE_1 = -27.2\text{eV}$

(10) $E_n = \frac{-13.6\ eV}{n^2} \Rightarrow E_6 = 0.378eV,\ E_2 = 3.4eV$

$E_{ph} = E_6 - E_2 = 3.02\ eV$ //

$E = hf = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E} = \frac{1240eV \cdot nm}{3.02eV} = 410\ nm$ //

$c = f\lambda \Rightarrow f = \frac{c}{\lambda} = 7.32 \times 10^{14}\ Hz$ //

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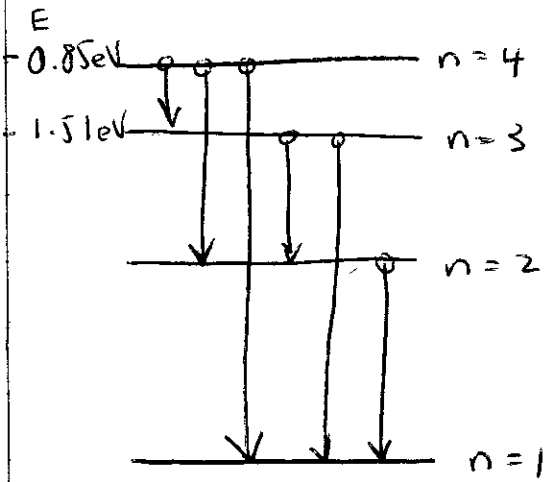
(20)



- 6 unique spectral lines

longest λ $\longleftrightarrow$ smallest E

$\Rightarrow n = 4 \rightarrow n = 3$

$\begin{cases} E_4 = \frac{-13.6\ eV}{16} = 0.85eV \\ E_3 = \frac{-13.6\ eV}{9} = 1.51eV \end{cases}$

$\Rightarrow E_{ph} = 0.66\ eV = \frac{hc}{\lambda}$

$\Rightarrow \lambda = \frac{1240\ eV \cdot nm}{0.66\ eV} = 1879\ nm$

(28) $E_n = -13.6\,eV\,\frac{Z^2}{n^2}$; here $Z=2$ for He

$\Rightarrow E_n = -\frac{54.4\,eV}{n^2}$

energy levels:

E_n(eV)

-2.18 —— $n=5$

-3.40 —— $n=4$

-6.04 —— $n=3$

-13.6 —— $n=2$

-54.4 —— $n=1$

to ionize He^+, need to strip e^- from $n=1$ level

$\Rightarrow$ need 54.4 eV

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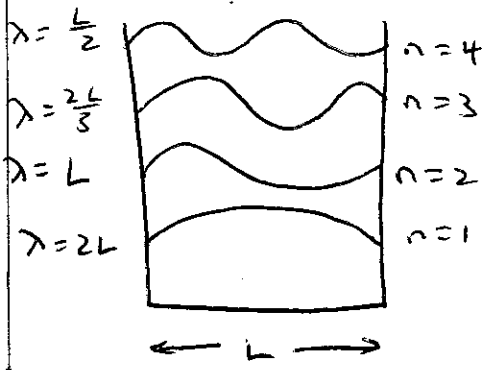
(32)



require $\lambda_n = \frac{2L}{n}$ for integer n

and $p = \frac{h}{\lambda}$ (de Broglie)

$\Rightarrow p = \frac{h}{(2L/n)} = \frac{hn}{2L}$ //

no potential $\Rightarrow E = KE = \frac{p^2}{2m} = \frac{\left(\frac{h^2 n^2}{4L^2}\right)}{2m} = \frac{h^2 n^2}{8mL^2}$

$\equiv E_0 n^2$ //

(34) for $n = 4$

$\ell = 0, 1, \ldots, n-1 = \underline{0, 1, 2, 3}$

4 possible ℓ states

$m = -\ell, -\ell+1, \ldots, \ell-1, \ell = \underline{-3, -2, -1, 0, 1, 2, 3}$

$2\ell+1 = 7$ possible m states

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(36) oxygen : $1s^2\ 2s^2\ 2p^4$

$1s^2$	$2s^2$	$2p^4$
$n = 1$	$n = 2$	$n = 2$
$\ell = 0$	$\ell = 0$	$\ell = 1$
$m = 0$	$m = 0$	$m = 0, 1$
$s = \pm 1/2$	$s = \pm 1/2$	$s = \pm 1/2$
⇓	⇓	⇓
2 states	2 states	4 states

$|n\ \ell\ m\ s\rangle =$ $|1\ 1\ 0\ 0\ \tfrac{1}{2}\rangle$ $|1\ 1\ 0\ 0\ -\tfrac{1}{2}\rangle$ $|2\ 0\ 0\ 0\ \tfrac{1}{2}\rangle$ $|2\ 0\ 0\ 0\ -\tfrac{1}{2}\rangle$ $|2\ 1\ 0\ 0\ \tfrac{1}{2}\rangle$ $|2\ 1\ 0\ 0\ -\tfrac{1}{2}\rangle$ $|2\ 1\ 1\ 0\ \tfrac{1}{2}\rangle$ $|2\ 1\ 1\ 0\ -\tfrac{1}{2}\rangle$

⇒ 8 states total for each of the 8 e^-