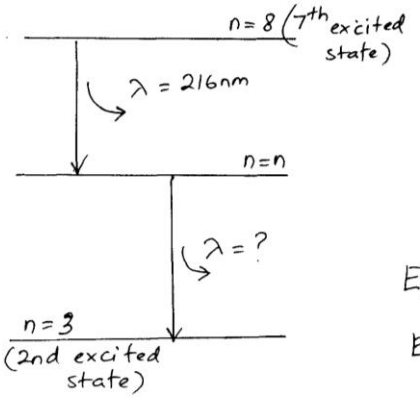
KSCP : 2003/2004 : QUANTUM THEORY



Given : $E = -2.18\times10^{-18}\left(\frac{Z^2}{n^2}\right)J$

$$\Delta E = \frac{hc}{\lambda} = \frac{(6.626\times10^{-34})(2.998\times10^{8})}{(216\times10^{-9}\,m)}$$

$$\Delta E = 9.197\times10^{-19}\,J\,photon^{-1}$$

$$E_8 = -2.18\times10^{-18}\left(\frac{3^2}{8^2}\right)J = -3.066\times10^{-19}\,J$$

$$E_n = -2.18\times10^{-18}\left(\frac{3^2}{n^2}\right)J = \frac{-1.962\times10^{-17}}{n^2}\,J$$

$Li^+ (Z = 3)$ $\quad \Delta E = E_8 - E_n$

$$9.197\times10^{-19} = \left(-3.066\times10^{-19}\right) - \left(\frac{-1.962\times10^{-17}}{n^2}\right)$$

$$n^2 = 16$$

$$\therefore n = 4 \text{ (Ans)}$$

$$\Delta E = \frac{hc}{\lambda} = E_4 - E_3 = \left(\frac{-1.962\times10^{-17}}{4^2}\right) - \left(\frac{-1.962\times10^{-17}}{3^2}\right)$$

$$\frac{(6.626\times10^{-34})(2.998\times10^{+8})}{\lambda} = 9.54\times10^{-19}$$

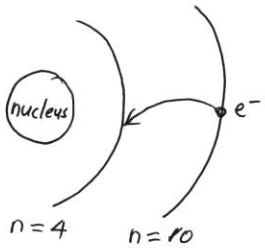
$$\therefore \lambda = 2.08\times10^{-7}\,m$$

$$= 208\ nm \text{ (Ans)}$$

KSCP 2003/2004 : Q2e

KSCP 2003/04 : Quantum Theory.

Q2(e)



$$\bar{\nu} = \frac{1}{\lambda} = R_H\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] \quad \text{where } n_1 < n_2$$

$$\frac{1}{\lambda} = (109678\ cm^{-1})\left[\frac{1}{4^2} - \frac{1}{10^2}\right]$$

$$\frac{1}{\lambda} = 5758.1\ cm^{-1}$$

$$\lambda = 1.74 \times 10^{-4}\ cm$$

$$= 1.74 \times 10^{-4} \times 10^{7}\ nm$$

$$\lambda = 1740\ nm$$

$1nm = 10^{-7}\ cm$
$= 10^{-9}\ m$

KSCP 2003/2004 : Q3a

KSCP 2003/04 : QUANTUM THEORY

Q3 (a) $n = 4$ $l = 0$ $m_l = 0$

$l = 1$ $m_l = +1, 0, -1$

$l = 2$ $m_l = +2, +1, 0, -1, -2$

$l = 3$ $m_l = +3, +2, +1, 0, -1, -2, -3$

n	l	m_l	s
4	0	0	$+\frac{1}{2}$
4	0	0	$-\frac{1}{2}$
4	1	+1	$+\frac{1}{2}$
4	1	+1	$-\frac{1}{2}$
4	1	0	$+\frac{1}{2}$
4	1	0	$-\frac{1}{2}$
4	1	-1	$+\frac{1}{2}$
4	1	-1	$-\frac{1}{2}$
4	2	+2	$+\frac{1}{2}$
4	2	+2	$-\frac{1}{2}$
4	2	+1	$+\frac{1}{2}$
4	2	+1	$-\frac{1}{2}$
4	2	0	$+\frac{1}{2}$
4	2	0	$-\frac{1}{2}$
4	2	-1	$+\frac{1}{2}$
4	2	-1	$-\frac{1}{2}$
4	2	-2	$+\frac{1}{2}$
4	2	-2	$-\frac{1}{2}$
4	3	+3	$+\frac{1}{2}$
4	3	+3	$-\frac{1}{2}$
4	3	+2	$+\frac{1}{2}$
4	3	+2	$-\frac{1}{2}$
4	3	+1	$+\frac{1}{2}$
4	3	+1	$-\frac{1}{2}$
4	3	0	$+\frac{1}{2}$
4	3	0	$-\frac{1}{2}$
4	3	-1	$+\frac{1}{2}$
4	3	-1	$-\frac{1}{2}$
4	3	-2	$+\frac{1}{2}$
4	3	-2	$-\frac{1}{2}$
4	3	-3	$+\frac{1}{2}$
4	3	-3	$-\frac{1}{2}$

16 electrons have $s = -\frac{1}{2}$ //

3(b) $2Cl \longrightarrow Cl_2$ Energy released = 328 kJ mol^{-1} of Cl_2

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

(E: J $photon^{-1}$)

(very important step)

$$* \quad 328\ kJ\,mol^{-1} = \frac{(328 \times 10^3)\ J\,mol^{-1}}{(6.023 \times 10^{23})\ molecules\ mol^{-1}} = 5.45 \times 10^{-19}\ J\,molecule^{-1}$$

$$\therefore \lambda = \frac{(6.626 \times 10^{-34}\ J\,s)(3.0 \times 10^8\ m\,s^{-1})}{(5.45 \times 10^{-19}\ J\,molecule^{-1})} = 3.647 \times 10^{-7}\ m$$

$$\therefore \lambda = 3.647 \times 10^{-7} \times 10^9\ nm = 365\ nm\ (Ans)\ //$$

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