الحلول المقترحة

التمرين الأول:

$\lambda = 100\ \text{nm} = 100\ \times 10^{-9}\ \text{m}$

$\text{E}_\text{c} = 10\ \text{ev} = 10\ \times 1{,}6\ \times 10^{-19}\ \text{J}$

1) $E_c = \frac{1}{2}\ m\ v^2 \Rightarrow v = \sqrt{\frac{2E_c}{m}} = \sqrt{\frac{2\times10\times1{,}6\times10^{-19}}{9{,}1\times10^{-31}}} = 1{,}88\times10^6\ m/s$

2) $E_{ph} = E_0 + E_c$

$\Rightarrow E_0 = \frac{hc}{\lambda} - E_c = \frac{6{,}62\times10^{-34}\times3\times10^8}{100\times10^{-9}} - 10\times1{,}6\times10^{-19}$

$\Rightarrow E_0 = \frac{3{,}86\times10^{-19}}{1{,}6\times10^{-19}} = 3{,}86\times10^{-19}\ \text{J} = 2{,}41\ ev$

3) $E_0 = h\upsilon_0 \Rightarrow \upsilon_0 = \frac{E_0}{h} = \frac{3{,}86\times10^{-19}}{6{,}62\times10^{-34}} = 5{,}8\times10^{14}\ s^{-1}$

4) $T = \frac{1}{\upsilon_0} = \frac{1}{5{,}8\times10^{14}} = 1{,}72\times10^{-15}s$

5) $E_0 = \frac{hc}{\lambda_0} \Rightarrow \lambda_0 = \frac{hC}{E_0} = \frac{6{,}62\times10^{-34}\times3\times10^8}{3{,}86\times10^{-19}} = 5{,}15\times10^{-7}\ m$

6) $\bar{\upsilon_0} = \frac{1}{\lambda_0} = \frac{1}{5{,}15\times10^{-7}} = 1{,}94\times10^6 m^{-1}$

التمرين الثاني :

1) $r_n = \frac{n^2}{z}\times a_1 \quad , a_1 = 0{,}53\ \text{A}^\circ$

$v_n = \frac{z}{n}\times v_1 \quad , v_1 = 2{,}18\ \times10^6\ \text{m/s}$

$E_n = \frac{z^2}{n}\times E_1 \quad , E_1 = -13{,}6\ \text{ev}$

$r_2 = 4\times0{,}53 = 2{,}12\ \text{A}^\circ$

$r_3 = 9\times0{,}53 = 4{,}77\ A^\circ$

$r_4 = 16\times0{,}53 = 8{,}48\ \text{A}^\circ$

$v_2 = \frac{1}{2}\times2{,}18\times10^6 = 1{,}09\times10^6\ \text{m/s}$

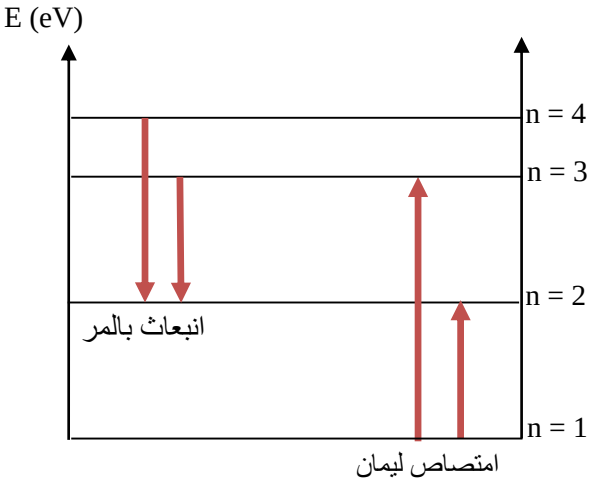
$v_3 = \frac{1}{3}\times2{,}18\times10^6 = 0{,}73\times10^6\ m/s$

$v_4 = \frac{1}{4}\times2{,}18\times10^6 = 0{,}54\times10^6\ \text{m/s}$

$E_2 = \frac{-1}{4}\times3{,}16 = -3{,}4\ ev$

$E_3 = \frac{-1}{9}\times3{,}16 = -1{,}51\ ev$

$E_4 = \frac{-1}{16}\times3{,}16 = -0{,}85\ ev$



2) $\Delta E_{1\to2} = |E_2 - E_1| = |-3{,}4 + 13{,}6| = 10{,}2\ ev$

$\Delta E_{1\to3} = |E_3 - E_1| = |-1{,}51 + 13{,}6| = 12{,}09\ ev$

$\Delta E_{3\to2} = |E_3 - E_1| = |-1{,}51 + 3{,}4| = 1{,}89\ ev$

$\Delta E_{4\to2} = |E_4 - E_1| = |-0{,}85 + 3{,}4| = 2{,}55\ ev$

$$\Delta E = h\upsilon = \frac{hC}{\lambda} = hC \times \frac{1}{\lambda} \Longrightarrow \bar{\upsilon} = \frac{1}{\lambda} = \frac{\Delta E}{hC}$$

$$\begin{cases} \bar{\upsilon}_{1\to2} = \frac{\Delta E_{1\to2}}{hC} = \frac{10.2\times1.6\times10^{-19}}{6{,}62\times10^{-34}\times3\times10^{8}} = 819\times10^{4}\ m^{-1} \\ \bar{\upsilon}_{1\to3} = \frac{\Delta E_{1\to3}}{hC} = \frac{12.09\times1.6\times10^{-19}}{6{,}62\times10^{-34}\times3\times10^{8}} = 974\times10^{4}\ m^{-1} \end{cases}$$

$$\begin{cases} \bar{\upsilon}_{3\to2} = \frac{\Delta E_{3\to2}}{hC} = \frac{1.89\times1.6\times10^{-19}}{6{,}62\times10^{-34}\times3\times10^{8}} = 152\times10^{4}\ m^{-1} \\ \bar{\upsilon}_{4\to2} = \frac{\Delta E_{4\to2}}{hC} = \frac{2.55\times1.6\times10^{-19}}{6{,}62\times10^{-34}\times3\times10^{8}} = 205\times10^{4}\ m^{-1} \end{cases}$$

$n \to n+1$: الخط الأول في أية سلسلة

$n \to \infty$: الخط الحدي في أية سلسلة

$$\frac{1}{\lambda_1} = R_H \times \left[\frac{1}{n^2} - \frac{1}{(n+1)^2}\right],$$

$$\frac{1}{\lambda_\infty} = \frac{R_H}{n^2} \Longrightarrow \lambda_\infty = \frac{n^2}{R_H}$$

السلسلة	$\lambda_n(nm)$	λ_∞(nm)	الطيف
Lyman	121	91	UV
Balmer	656	365	VIS
Pashen	1875	821	IR
Brakett	4052	1459	IR
Pfund	7460	2279	IR

التمرين الثالث :

λ = 4040 nm, Brakett ⟹ n=4

$$\frac{1}{\lambda} = R_H \times \left[\frac{1}{4^2} - \frac{1}{n^2}\right] \Longrightarrow \frac{1}{\lambda R_H} = \frac{1}{16} - \frac{1}{n^2}$$

$$\Longrightarrow \frac{1}{n^2} = \frac{1}{16} - \frac{1}{\lambda\, R_H} = \frac{1}{16} - \frac{1}{4040\times10^{-9}\times1{,}1\times10^{7}} \Longrightarrow n^2 = 25 \Longrightarrow n = 5$$

الموافق الإنتقال $(5 \leftarrow 4)$

الخط الثاني :

$4 \to 6$

$$\Delta E_{4\to6} = |E_6 - E_4| = \left|-\frac{1}{6^2}\times13{,}6 + \frac{1}{4^2}\times13{,}6\right| = 0{,}472\ ev$$

$$\frac{1}{\lambda_1} = R_H \times \left[\frac{1}{n^2} - \frac{1}{\underbrace{\infty^2}_{0}}\right] \Longrightarrow \frac{1}{\lambda R_H} = \frac{1}{n^2} \Longrightarrow n^2 = \lambda\, R_H = 820{,}8\times10^{-9}\times1{,}1\times10^{7} = 9 \Longrightarrow n = 3$$

هذا يعني أن السلسة (1) هي سلسلة باشن و الإنتقال $\infty \rightarrow 3$ بينما السلسة (2) هي سلسلة براكت لأن (n+1 = 4) و الإنتقال الحاصل $5 \rightarrow 4$

$$\frac{1}{\lambda_{(2)}} = R_H \times \left[\frac{1}{(n+1)^2} - \frac{1}{(n+2)^2}\right]$$

$$n = 3 \Longrightarrow \frac{1}{\lambda_2} = R_H \times \left[\frac{1}{4^2} - \frac{1}{5^2}\right] = 1{,}1 \times 10^7 \times \left[\frac{1}{16} - \frac{1}{25}\right] = 4{,}040 \times 10^{-6}\, m$$

$$\Longrightarrow \lambda_2 = 4040\, nm$$

$$* \quad \Delta E_1 = \frac{hC}{\lambda_1} \quad , \quad \Delta E_2 = \frac{hC}{\lambda_2} \quad \Longrightarrow \frac{\Delta E_1}{\Delta E_2} = \frac{\lambda_2}{\lambda_1} = \frac{4040}{820{,}8} = 4{,}9$$

$$\Delta E_{(1)_{\infty \rightarrow 3}} = \left|\underbrace{E_{\infty}}_{0} + \frac{1}{9} \times 13{,}6\right| = 1{,}51\, ev$$

$$\Delta E_{(2)_{5 \rightarrow 4}} = \left|-\frac{1}{16} \times 13{,}6 + \frac{1}{25} \times 13{,}6\right| = 0{,}306\, ev$$

<u>التمرين الرابع:</u>

$$E_n = \frac{z^2 E_1}{n^2} = -7{,}65\, ev$$

في حالة إثارة ثالثة : n=4

$$Z = \sqrt{\frac{n^2 E_n}{E_1}} = \sqrt{\frac{16 \times (-7{,}65)}{-13{,}6}}$$

$$\Longrightarrow z = 3 \Longrightarrow \quad Z - q = 1 \Rightarrow q = 2\,, \Longrightarrow \quad {}_3X^{+2}$$

الإنتقال من $5 \leftarrow 3$

$$\frac{1}{\lambda} = z^2 \times R_H \times \left(\frac{1}{9} - \frac{1}{25}\right) = 9 \times 1{,}1 \times 10^7 \times \left(\frac{1}{9} - \frac{1}{25}\right)$$

$$\Longrightarrow \lambda = 1{,}420 \times 10^{-7}\, m = 1420\, A^{\circ}$$

$$\begin{cases} \dfrac{1}{\lambda_H} = R_H \times \left(\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right) \\ \dfrac{1}{\lambda_{x^{2+}}} = z^2 \times R_H \times \left(\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right) \end{cases}$$

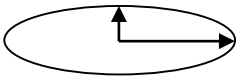
$$\Longrightarrow \lambda_{x^{2+}} = \frac{\lambda_H}{z^2} \Longrightarrow \lambda_H = z^2 \times \lambda_{x^{2+}} = 9 \times 1420 = 12780\, A^{\circ}$$

حالة إثارة أولى : n = 2

$$E_{x^{2+}} = \frac{-z^2 E_1}{n^2} = \frac{-9(-13{,}6)}{4} = 30{,}6\, ev$$

$$E_H = -\frac{E_1}{n^2} = \frac{13{,}6}{4} = 3{,}4\, ev$$

حساب نصف القطر الكبير a و الصغير b :



نصف القطر الكبير a :

$$a = r_n \quad , \quad r_n = \frac{n^2}{z} \times a_1$$

$$N \Longrightarrow n = 4 \Longrightarrow r_4 = \frac{16}{4} \times 0{,}53 = 2{,}12\ A^{\circ}$$

نصف القطر الصغير b :

$$N \Longrightarrow n = 4 \Longrightarrow l = 0\ ,1\ ,2\ ,3\ ;\ \frac{b}{a} = \frac{l+1}{4}$$

$$l = 0 \Longrightarrow \frac{b}{a} = \frac{1}{4} \Longrightarrow b = 0{,}53\ A^{\circ}$$

$$l = 1 \Longrightarrow \frac{b}{a} = \frac{2}{4} \Longrightarrow b = 1{,}06\ A^{\circ}$$

$$l = 2 \Longrightarrow \frac{b}{a} = \frac{3}{4} \Longrightarrow b = 1{,}59\ A^{\circ}$$

$$l = 3 \Longrightarrow \frac{b}{a} = \frac{4}{4} \Longrightarrow b = a = 2{,}12\ A^{\circ}$$

الإتجاهات النسبية للطبقة الثانوية 4p :

$$4p \Longrightarrow l = 1 \Longrightarrow m = -1\ ,0\ ,1$$

$$\cos\theta = \frac{m}{l}$$

$$\cos\theta_1 = \frac{-1}{1} \Longrightarrow \theta = \pi$$

$$\cos\theta_2 = \frac{0}{1} \Longrightarrow \theta = \pi/2$$

$$\cos\theta_3 = \frac{1}{1} \Longrightarrow \theta = 0$$