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MIME 262

Assignment 1

Q5

Q5

$\Delta E = E_{init} - E_{final} = -A/n_{ini}^2 + A/n_{final}^2$, $n_{ini} = 5$

for $n_{final} = 1$; $\Delta E = -A/5^2 + A/1^2 = 13.6eV(1 - 1/25) = 13.056eV \simeq 13.06eV$

$n_{final} = 2$; $\Delta E = 13.6eV(1/4 - 1/25) = 2.856eV$

$n_{final} = 3$; $\Delta E = 13.6eV(1/9 - 1/25) \simeq 0.97eV$

$E = h\nu \Rightarrow \frac{E}{h} = \nu$, $\lambda = c/\nu$

for $n_{final} = 1$, $\nu_1 = \frac{13.06 \cdot 1.6 \cdot 10^{-19}}{6.626 \cdot 10^{-34}} \simeq 3.16 \cdot 10^{15} Hz$ $\lambda = \frac{3 \cdot 10^8}{3.16 \cdot 10^{15}} \simeq 95nm$

" $= 2$, $\nu_2 = 0.69 \cdot 10^{15} Hz$, $\lambda = 434nm$

" $= 3$, $\nu_3 = 0.23 \cdot 10^{15} Hz$, $\lambda = 1.2\mu m$

Q2

Q2 $\Phi_c = E_e + E_r = \left(\frac{-N_A e^2}{4\pi\varepsilon_0 r}\alpha Z^2 + \frac{N_A B}{r^n}\right)$

$E_e = N_A\left(\frac{-e^2}{4\pi\varepsilon_0 r}\right)\alpha Z^2$

$E_r = \frac{N_A B}{r^n}$

⇒ To find constants at equilibrium, we find minimum energy. The energy being a function of the distance r we get:

$\frac{d\Phi_c}{dr} = 0 = \frac{N_A e^2 \alpha Z^2}{4\pi\varepsilon_0 r^2} - \frac{N_A B n}{r^{n+1}} = 0$

$\Rightarrow B = \frac{N_A e^2 \alpha Z^2}{n \cdot 4\pi\varepsilon_0 r^2 \cdot N_A} \cdot r^{n+1} = \frac{e^2 \alpha Z^2 r^{n-1}}{n 4\pi\varepsilon_0}$

$U_{min} = \Phi_{c\,min} = -\left(\frac{N_A \alpha Z^2 e^2}{4\pi\varepsilon_0 r}\right)\left(1 - \frac{1}{n}\right)$