① A $\quad -\dfrac{\hbar^2}{2m}\left(\dfrac{d^2R}{dr^2} + \dfrac{2}{r}\dfrac{dR}{dr}\right) + \left(V + \dfrac{\ell(\ell+1)\hbar^2}{2mr^2}\right)R = E\ell$

B $\quad E_n = -\dfrac{13,6\,eV}{n^2} = -\dfrac{e^4 m_e}{2(4\pi\varepsilon_0\hbar)^2}\cdot\dfrac{1}{n^2}$

C $\quad \rho(r) = r^2 |R(r)|^2$

D $\quad R_{n\ell}(r) = e^{-\frac{zr}{na_0}}\, r^\ell \cdot pol$ en r de grado $n-1-\ell$

E $\quad \langle r\rangle_{2s} = \displaystyle\int_0^{\infty} r^2 r\,\dfrac{1}{8a_0^3}\left(4 - \dfrac{4r}{a_0} + \dfrac{r^2}{a_0^2}\right)e^{-r/a_0}\,dr = \left[\begin{array}{l} u = r/a_0 \\ du = dr/a_0\end{array}\right]$

$\quad = \displaystyle\int_0^{\infty}\left(\dfrac{u^3}{2} - \dfrac{u^4}{2} + \dfrac{u^5}{8}\right)e^{-u}\,du = \dfrac{3!}{2} - \dfrac{4!}{2} + \dfrac{5!}{8}\,a_0 = 3 - 12 + 15 = 6a_0$

$\langle r\rangle_{2p} = \displaystyle\int \dfrac{r^3}{3}\cdot\dfrac{r^2}{a_0^2}\cdot\dfrac{1}{8a_0^3}\,e^{-r/a_0}\,dr = a_0\cdot\dfrac{5!}{24} = 5a_0$

F $\quad \langle V\rangle_{2s} = \displaystyle\int\dfrac{Ke^2}{a_0}\dfrac{r\,dr}{8a_0^2}\left(4 - \dfrac{4r}{a_0} + \dfrac{r^2}{a_0^2}\right)e^{-r/a_0} = \dfrac{Ke^2}{a_0}\left(\dfrac{1}{2} - \dfrac{2!}{2} + \dfrac{3!}{8}\right) = \dfrac{Ke^2}{4a_0}$

$\langle V\rangle_{2p} = \displaystyle\int\dfrac{Ke^2}{3a_0}\dfrac{r^3\,dr}{8a_0^4}\,e^{-r/a_0} = \dfrac{6}{3\cdot8}\dfrac{Ke^2}{a_0} = \dfrac{Ke^2}{4a_0} = \langle V\rangle_{2s}$

② $\quad E_B = U_c + U_{r\cdot p} + \Delta E$

D $\quad$ A esa distancia, $U_{r.p.}\approx 0$

$\quad$ Buscamos $r / E_B = 0 \;\rightsquigarrow\; \dfrac{Ke^2}{r} = \Delta E \;\rightsquigarrow\; r = \dfrac{Ke^2}{\Delta E} = 9,413\times10^{-10}\,m = 9,41\text{\AA}$

$\underline{\underline{E}}$ $r_{eq} = 0,236\,nm$

$E_B = -4,26\,eV$ $\left.\begin{array}{l}\\\\\end{array}\right\}$ $U_{r.p} = E_B - \Delta E - U_c = -4,26\,eV - 1,53\,eV + 6,10\,eV \approx 0,31\,eV$

$\underline{\underline{F}}$ Estimando $E_B \approx 4\,eV \rightarrow$ $U_{r.p} = +4\,eV - 1,53\,eV + 14,40\,eV \approx 16,9\,eV$