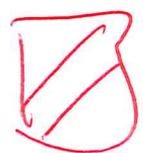


① Vetrifaðhleðsla

Margfeldni $2^2 P_{1/2}$ og $2^2 P_{3/2}$
eru 2 og 4, en orkumunur
milli þeirra og $1^2 S_{1/2}$
er up.b. sá sami.

Þess vegna er styrkhleffall
lína

$$\frac{2^2 P_{1/2} \rightarrow 1^2 S_{1/2}}{2^2 P_{3/2} \rightarrow 1^2 S_{1/2}} = \frac{1}{2}$$



2. Electron in a Thomson atom

Consider an electron oscillating along a diameter. When at a distance r from the center of the atom, the force acting on the electron is

$$F = \frac{1}{4\pi\epsilon_0} \frac{4\pi r}{3} r^3 g \frac{e}{r^2}$$

where

$$g = \frac{e}{\frac{4\pi R^3}{3}} > 0$$

since the net charge on atom-electron is $+e$. Therefore,

$$F = \frac{1}{4\pi\epsilon_0} \frac{e^2}{R^3} r$$

This force is attractive, i.e

directed toward the center of the atom. Hence, since

$$F = ma$$

we have

$$-\frac{1}{4\pi\epsilon_0} \frac{e^2}{R^2} r = m r$$

and

$$\omega^2 = \frac{1}{4\pi\epsilon_0} \frac{e^2}{mR^3}$$

If the electron revolves in a circular orbit of radius R then $F = ma$

$$\frac{1}{4\pi\epsilon_0} \frac{e^2}{R^2} = m \frac{v^2}{R} = m \frac{(R\omega)^2}{R} = mR\omega^2$$

which gives

$$\omega^2 = \frac{1}{4\pi\epsilon_0} \frac{e^2}{mR^3}$$

The two frequencies are seen to be equal. The

equality applies also to oscillations of amplitude less than R and circular orbits of radius less than R , since the charge exterior to the amplitude or radius exerts zero force on the electron for spherically asymmetric charge distributions.



3.

speed of a proton in a hydrogen atom

The periods of revolution of electron and proton are equal

$$\frac{2\pi r_e}{V_e} = \frac{2\pi r_p}{V_p}$$

we find

$$V_p = \frac{r_p}{r_e} V_e$$

The motion is about the center of mass of the electron-proton system, so that

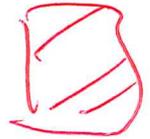
$$m_p r_p = m_e r_e \Rightarrow \frac{r_p}{r_e} = \frac{m_e}{m_p}$$

and therefore

$$V_p = \frac{m_e}{m_p} V_e = \frac{m_e}{m_p} c \approx \frac{c}{137}$$

and

$$V_p = \frac{1}{1836} \frac{3 \times 10^8}{137} = 1.2 \times 10^3 \text{ m/s}$$



4.

Isotope shift

0.18 nm



3.

(a) Tidni fyrstu línu

$$\lambda_1 = \frac{c}{\nu_1} = cR_H \left(\frac{1}{m^2} - \frac{1}{(m+1)^2} \right)$$

Tidni við útmörk radar

$$\lambda_\infty = \frac{c}{\nu_\infty} = cR_H \left(\frac{1}{m^2} - 0 \right)$$

þar með er

$$\Delta \nu = \nu_\infty - \nu_1 = \frac{cR_H}{(m+1)^2}$$

(b)

$$\frac{\Delta \nu_{Ly}}{\Delta \nu_{Pf}} = \frac{cR_H / (1+1)^2}{cR_H / (5+1)^2} = 9$$

