Formulario: Rudik Rompich

Capítulo 3

1. Descubrimiento rayos X – Electrón

$$\tan\theta = \frac{v_y}{v_x} = \frac{a_y t}{v_0} = \frac{qE}{m}\frac{\ell}{v^2{}_0} \qquad \vec{F} = q\vec{E} + q\vec{v}\times\vec{B} = 0 \qquad v_x = \frac{E}{B} = v_0$$

$$\frac{q}{m} = \frac{v^2{}_0 \tan\theta}{E\ell} = \frac{E\tan\theta}{B^2\ell}$$

2. Carga del electrón
3. Línea espectral

$$\lambda = \lambda_{\text{limit}}\frac{n^2}{n^2 - n_0^2} \qquad (n = n_0 + 1, n_0 + 2, n_0 + 3\ldots)$$

$$\frac{1}{\lambda} = R_{\text{H}}\left(\frac{1}{n^2} - \frac{1}{k^2}\right)$$

Figure 2- Rydberg

$$d\sin\theta = n\lambda$$

Figure 1- Máxima difracción

4. Cuantización
5. Radiación de cuerpo negro

$$\lambda_{\max}T = 2.898\times 10^{-3}\,\text{m}\cdot\text{K}$$

Figure 6 - Wien desplazamiento

$$R(T) = \epsilon\sigma T^4$$

Figure 5 - Stefan-Boltzmann

$$\mathcal{I}(\lambda,\text{T}) = \frac{2\pi ckT}{\lambda^4}$$

Figure 4 - Rayleigh-Jeans

$$\mathcal{I}(\lambda, T) = \frac{2\pi c^2 h}{\lambda^5}\frac{1}{e^{hc/\lambda kT} - 1}$$

Figure 3-Radiación de Planck

$$h = 6.6261\times 10^{-34}\,\text{J}\cdot\text{s} \qquad E_n = nhf, \quad \Delta E = hf$$

6. Efecto fotoeléctrico

Einstein

$$E = hf \qquad \lambda f = c \qquad hf = \phi + \text{K.E. (electron)} \qquad hf = \phi + \tfrac{1}{2}mv_{\max}^2 \qquad eV_0 = \tfrac{1}{2}mv_{\max}^2$$

Cuántico

$$\tfrac{1}{2}mv_{\max}^2 = eV_0 = hf - \phi \qquad eV_0 = \tfrac{1}{2}mv_{\max}^2 = hf - hf_0 = h(f - f_0) \qquad E = hf = \frac{hc}{\lambda}$$

7. Producción de X-Ray

$$E_f = E_i - hf \qquad eV_0 = hf_{\max} = \frac{hc}{\lambda_{\min}} \qquad \lambda_{\min} = \frac{hc}{e}\frac{1}{V_0} = \frac{1.240\times 10^{-6}\,\text{V}\cdot\text{m}}{V_0}$$

Figure 7-Duane-Hunt

8. Efecto Compton

$$p = \frac{E}{c} = \frac{hf}{c} = \frac{h}{\lambda}$$

$$E_e^2 = (mc^2)^2 + p_e^2 c^2$$

$$\text{Energy} \quad hf + mc^2 = hf' + E_e$$

$$p_x \qquad \frac{h}{\lambda} = \frac{h}{\lambda'}\cos\theta + p_e \cos\phi$$

$$p_e^2 = \left(\frac{h}{\lambda}\right)^2 + \left(\frac{h}{\lambda'}\right)^2 - 2\left(\frac{h}{\lambda}\right)\left(\frac{h}{\lambda'}\right)\cos\theta$$

$$p_y \qquad \frac{h}{\lambda'}\sin\theta = p_e \sin\phi$$

$$\Delta\lambda = \lambda' - \lambda = \frac{h}{mc}(1 - \cos\theta)$$

z

9. Producción de pares y aniquilación

$$\gamma \rightarrow e^+ + e^-$$

$$hf = E_+ + E_- + \text{K.E. (nucleus)}$$

Capitulo 4

$$hf > 2m_e c^2 = 1.022\ \text{MeV} \qquad \text{(for pair production)}$$

$$\text{Energy} \qquad 2m_e c^2 \approx hf_1 + hf_2$$

$$\text{Momentum} \quad 0 = \frac{hf_1}{c} - \frac{hf_2}{c}$$

$$hf = m_e c^2 = 0.511\ \text{MeV}$$

1. Estructura del átomo
2. Rutherford

$$\Delta\vec{p} = \vec{p}_f - \vec{p}_i \qquad \Delta p = 2mv_0 \sin\frac{\theta}{2} \qquad \vec{F} = \frac{1}{4\pi\epsilon_0}\frac{Z_1 Z_2 e^2}{r^2}\hat{e}_r$$

$$F_{\Delta p} = F\cos\phi \qquad b = \frac{Z_1 Z_2 e^2}{8\pi\epsilon_0 K}\cot\frac{\theta}{2} \qquad \sigma = \pi b^2$$

$$n = \frac{\rho\left(\frac{\text{g}}{\text{cm}^3}\right) N_A \left(\frac{\text{molecules}}{\text{mol}}\right) N_M \left(\frac{\text{atoms}}{\text{molecule}}\right)}{M_g\left(\frac{\text{g}}{\text{mol}}\right)} = \frac{\rho N_A N_M}{M_g} \frac{\text{atoms}}{\text{cm}^3}$$

$$nt = \frac{\rho N_A N_M t}{M_g} \frac{\text{atoms}}{\text{cm}^2}$$

$$N_s = ntA = \frac{\rho N_A N_M t A}{M_g} \text{ atoms}$$

$$f = \frac{\text{target area exposed by scatterers}}{\text{total target area}} = \frac{ntA\sigma}{A}$$

$$= nt\sigma = nt\pi b^2$$

$$f = \pi nt \left(\frac{Z_1 Z_2 e^2}{8\pi\epsilon_0 K}\right)^2 \cot^2\frac{\theta}{2}$$

$$N(\theta) = \frac{N_i nt}{16}\left(\frac{e^2}{4\pi\epsilon_0}\right)^2 \frac{Z_1^2 Z_2^2}{r^2 K^2 \sin^4(\theta/2)}$$

3. Modelo atómico clásico

$$\vec{F}_e = \frac{-1}{4\pi\epsilon_0}\frac{e^2}{r^2}\hat{e}_r \qquad a_r = \frac{v^2}{r} \qquad \frac{1}{4\pi\epsilon_0}\frac{e^2}{r^2} = \frac{mv^2}{r} \qquad v = \frac{e}{\sqrt{4\pi\epsilon_0 mr}}$$

4. Modelo de Bohr del átomo de hidrógeno

$$L = mvr = n\hbar \qquad v = \frac{n\hbar}{mr} \qquad v^2 = \frac{e^2}{4\pi\epsilon_0 mr} = \frac{n^2\hbar^2}{m^2r^2}$$

$$r_n = \frac{4\pi\epsilon_0 n^2\hbar^2}{me^2} \equiv n^2 a_0$$

$$a_0 = \frac{4\pi\epsilon_0\hbar^2}{me^2} = \frac{(1.055 \times 10^{-34}\,\text{J}\cdot\text{s})^2}{\left(8.99 \times 10^9\,\frac{\text{N}\cdot\text{m}^2}{\text{C}^2}\right)(9.11\times 10^{-31}\,\text{kg})(1.6\times 10^{-19}\,\text{C})^2} = 0.53 \times 10^{-10}\,\text{m}$$

$$E_n = -\frac{e^2}{8\pi\epsilon_0 r_n} = -\frac{e^2}{8\pi\epsilon_0 a_0 n^2} \equiv -\frac{E_0}{n^2}$$

$$E_0 = \frac{e^2}{8\pi\epsilon_0 a_0} = \frac{e^2}{(8\pi\epsilon_0)}\frac{me^2}{4\pi\epsilon_0\hbar^2} = \frac{me^4}{2\hbar^2(4\pi\epsilon_0)^2} = 13.6\text{ eV}$$

$$hf = E_u - E_\ell$$

$$\frac{1}{\lambda} = \frac{f}{c} = \frac{E_u - E_\ell}{hc}$$

$$= \frac{-E_0}{hc}\left(\frac{1}{{n_u}^2} - \frac{1}{{n_\ell}^2}\right) = \frac{E_0}{hc}\left(\frac{1}{{n_\ell}^2} - \frac{1}{{n_u}^2}\right) \quad \frac{E_0}{hc} = \frac{me^4}{4\pi c\hbar^3(4\pi\epsilon_0)^2} \equiv R_\infty$$

$$v_n = \frac{n\hbar}{mr_n} = \frac{n\hbar}{mn^2a_0} = \frac{1}{n}\frac{\hbar}{ma_0}$$

$$\frac{1}{\lambda} = R_\infty\left(\frac{1}{{n_\ell}^2} - \frac{1}{{n_u}^2}\right) \qquad v_n = \frac{1}{n}\frac{e^2}{4\pi\epsilon_0\hbar} \qquad \alpha \equiv \frac{v_1}{c} = \frac{\hbar}{ma_0c} = \frac{e^2}{4\pi\epsilon_0\hbar c} \approx \frac{1}{137}$$

5. El principio de correspondencia

$$f_{\text{classical}} = f_{\text{orb}} = \frac{\omega}{2\pi} = \frac{1}{2\pi}\frac{v}{r} \qquad f_{\text{classical}} = \frac{1}{2\pi}\left(\frac{e^2}{4\pi\epsilon_0 mr^3}\right)^{1/2} \qquad f_{\text{classical}} = \frac{me^4}{4{\epsilon_0}^2h^3}\frac{1}{n^3}$$

Orbital radius $\quad r_n = \dfrac{4\pi\epsilon_0\hbar^2}{me^2}n^2 = n^2a_0$

Velocity $\quad v_n = \dfrac{n\hbar}{mr_n}$

Energy $\quad E_n = -\dfrac{e^2}{8\pi\epsilon_0 a_0 n^2}$

$$f_{\text{Bohr}} = \frac{me^4}{4{\epsilon_0}^2h^3}\frac{1}{n^3} = f_{\text{classical}}$$

6. Errores del modelo de Bohr - Reducción de masa

$$\mu_e = \frac{m_eM}{m_e + M} = \frac{m_e}{1 + \dfrac{m_e}{M}} \qquad R = \frac{\mu_e}{m_e}R_\infty = \frac{1}{1 + \dfrac{m_e}{M}}R_\infty = \frac{\mu_e e^4}{4\pi c\hbar^3(4\pi\epsilon_0)^2}$$

$$\frac{1}{\lambda} = Z^2R\left(\frac{1}{{n_\ell}^2} - \frac{1}{{n_u}^2}\right)$$

7. Espectro Rayos-X y número atómico

$$E\ (\text{x ray}) = E_u - E_\ell \qquad f_{K_\alpha} = \frac{3cR}{4}(Z-1)^2$$

$$\frac{1}{\lambda_{K_\alpha}} = R(Z-1)^2\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3}{4}R(Z-1)^2 \qquad f_{K_\alpha} = \frac{c}{\lambda_{K_\alpha}} = \frac{3cR}{4}(Z-1)^2$$

$$\frac{1}{\lambda_K} = R(Z-1)^2\left(\frac{1}{1^2} - \frac{1}{n^2}\right) = R(Z-1)^2\left(1 - \frac{1}{n^2}\right)$$