1 Wave particle duality

Energy Quanta: $\hspace{11cm}$ (1)

$$u_v dv = \frac{8\pi v^2}{c^3} \cdot \frac{hv}{e^{\frac{hv}{K_b T}} - 1} \hspace{8cm} (2)$$

$$E = hv \hspace{10cm} (3)$$

Photoelectric Effect: $\hspace{10cm}$ (4)

$$\frac{1}{2}m_e v_k^2 = E_k = hv - W \hspace{7cm} (5)$$

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \hspace{7cm} (6)$$

$$R_H = 1.097373 \times 10^7 m^{-1} \hspace{3cm} n_1 = 1 \Rightarrow Lyman \hspace{0.5cm} (7)$$

$$n_1 = 2 \Rightarrow Balmer \hspace{7cm} (8)$$

$$n_1 = 3 \Rightarrow Paschen \hspace{7cm} (9)$$

$$n_1 = 4 \Rightarrow Brackett \hspace{7cm} (10)$$

$$n_1 = 15 \Rightarrow Pfund \hspace{7cm} (11)$$

$$n_2 > n_1 \hspace{9cm} (12)$$

De Broglie Relationship: $\hspace{3cm} E^2 = p^2 c^2 + m^2 c^4 \hspace{0.5cm} (13)$

for zero rest mass: $E^2 = p^2 c^2 \rightarrow E = pc \hspace{5cm} (14)$

$$hv = h\frac{c}{\lambda} = pc \hspace{8cm} (15)$$

$$\therefore p = \frac{h}{\lambda} \hspace{9cm} (16)$$

Electron diffraction $\hspace{10cm}$ (17)

$$E_K = eV - \frac{p^2}{2m} \tag{18}$$

$$p = \sqrt{2meV} \tag{19}$$

$$\lambda = \frac{h}{\sqrt{2meV}} \tag{20}$$

$$\lambda = 2d\sin(\theta) \tag{21}$$

$$\sin^2(\theta) = \frac{C}{V}, \text{ Where } C = \frac{h^2}{8med^2} \tag{22}$$

Bohr Model $\hspace{11cm}$ (23)

$$F_{centripedal} = F_{electric} \tag{24}$$

$$m\frac{v^2}{r} = \frac{e^2}{4\pi\epsilon_0 r^2} \tag{25}$$

$$\therefore v^2 = \frac{e^2}{4\pi\epsilon_0 mr} \tag{26}$$

$$I_{orbit} = n\lambda = 2\pi r \text{ Where n is the quantisation condition} \tag{27}$$

$$\therefore v = \frac{hn}{2\pi mr} \tag{28}$$

$$L = mvr = n\frac{h}{2\pi} = n\hbar \tag{29}$$

As such, allowed radii are described by the expression: $\hspace{5cm}$ (30)

$$r_n = \frac{h^2\epsilon_0 n^2}{\pi me^2} = a_{Bohr}n^2 \tag{31}$$

$$r_1 = a_{Bohr} = \frac{h^2\epsilon_0}{\pi me^2} = 5.3 \times 10^{-11}m \tag{32}$$

$$E_k = \frac{1}{2}mv^2 = \frac{e^2}{8\pi\epsilon_0 r} \tag{33}$$

$$E_T = E_k + E_c = \frac{e^2}{8\pi\epsilon_0 r} - \frac{e^2}{4\pi\epsilon_0 r^2} = -\frac{e^2}{8\pi\epsilon_0 r} \tag{34}$$

Substiting in r_n gives: $\hspace{9cm}$ (35)

$$E_T = -\left(\frac{me^4}{8\epsilon_0^2 h^2}\right) \cdot \frac{1}{n^2} = \frac{-13.6eV}{n^2}, \ 1 \ eV \approx 1.602 \times 10^{-19}J \tag{36}$$

$$\Delta E = E_i - E_f = \frac{me^4}{8\epsilon_0^2 h^2}(\frac{1}{n_f^2} - \frac{1}{n_i^2}) \tag{37}$$

$$textsince: E = hv = h\frac{c}{\lambda} \tag{38}$$

$$\frac{1}{\lambda} = \frac{me^4}{8\epsilon_0^2 h^3}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) = R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \tag{39}$$