Chapter 3
Intro To Quantum Physics

1/ Wave property of Electrons.

matter wave: sóng vật chất

2/ De Broglie's theory - matter wave

$E = hf$

$p = \frac{h}{\lambda} = mv$

$E = hf$: ~~elc power~~ energy of a photon

$p = h\frac{1}{\lambda}$: động lg of a photon (momentum)

particle, wave

h : plank constant

$p = m.v$

$K = \frac{1}{2}mv^2$: kinetic energy.

$\hbar = \frac{h}{2\pi}$ (đọc là ~~h ba~~ /eich/ $\hbar$ bar)

$$\boxed{\begin{aligned} \rightarrow E &= 2\pi.f.\hbar = \omega.\hbar \\ p &= \frac{2\pi}{\lambda}\hbar = k.\hbar \end{aligned}}$$

λ : de Broglie wavelength.

$\lambda = \frac{h}{p}$

~~1,6~~ $1eV = 1,6.10^{-19}J$

3/ The ~~scho~~ Schrödinger's equation.

for the case of one-dimensional motion.

when a particle with the mass m has a potential energy $U(x)$

Schrödinger's equation is:

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2}[E - U(x)]\psi = 0$$

de Broglie wavelength: $\frac{1}{\lambda} = \frac{p}{h}$

wave number : $k = \frac{2\pi}{\lambda}$

$|\psi|^2$: probability per unit time (xác suất tìm các particle)

Euler's formula:

$$\boxed{e^{ix} = \cos x + i\sin x} \quad \boxed{\cos x = \frac{e^{ix} + e^{-ix}}{2}} \quad \boxed{\sin x = \frac{e^{ix} - e^{-ix}}{2i}}$$

4/ The Heisenberg's uncertainty principle.

$h = 6{,}625 \cdot 10^{-34}$

$\hbar$ (h-bar) $= \frac{h}{2\pi}$

$$\boxed{\Delta x \cdot \Delta p \geq \hbar}$$

Uncertainty for energy: $\Delta E \cdot \Delta t \geq \hbar$

probl 3/ $v = 2 \cdot 10^6$ m/s

precision: 0,5 %

$m = 9{,}1 \cdot 10^{-31}$ kg

$\boxed{\Delta x \cdot \Delta p \geq \hbar}$

$\cancel{\Delta p =}$ $p = m \cdot v =$

$\Delta p = 0{,}5\% \cdot p$

$\Delta x = \frac{\hbar}{\Delta p}$

probl 4/ $\Delta x = 0{,}1$ mm $= 0{,}1 \cdot 10^{-3}$ m

$\Delta p = m \cdot \Delta v$

$\Delta v = \frac{\Delta p}{m} \geq \frac{\hbar}{\Delta x \cdot m}$

$K = \frac{1}{2} m v^2$

$p = m \cdot V$

$|\psi|^2$: probability per unit time (xác suất tìm đc particle)

Euler's formula:

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Uncertainty for energy. $\Delta E . \Delta t \geq \hbar$

5) Particle in a square well

Schrödinger's equation:

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2}{h^2} \cdot E\psi = 0$$

putting $k^2 = \frac{8\pi^2}{h^2} \cdot E$

$$\rightarrow \frac{d^2\psi}{dx^2} + k^2 \cdot \psi = 0$$

$\psi(x) = C \sin kx$

$k = \frac{n\pi}{a}$

$p = \hbar \cdot k$

$E = \frac{p^2}{2m}$

Bound states.

$$\boxed{E_n = \frac{h^2}{8ma^2} \cdot n^2}$$

$n = 1$: ground state (E_1)

$n = 2$: 1st excited state.

$n = 3$: 2nd ________

n: quantum number

probl 8)

$a = 100\,pm$

1/ $E_1 = \frac{h^2}{8 \cdot m \cdot a^2} \cdot n^2 =$

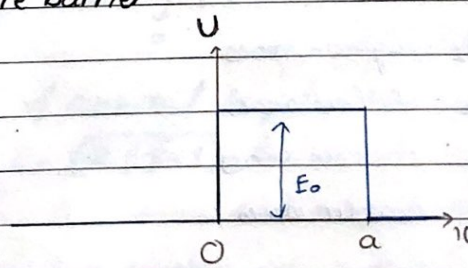
Normalization condition:

$$\int_{-\infty}^{+\infty} |\psi|^2 dx = 1$$

probl 9)

6/ Tunneling phenomena

a) the square barrier



Chapter 4: Atomic Physics

1/ The Bohr Atom

1.1/ The energy levels

$$\boxed{E_n = \frac{-13{,}6\,eV}{n^2}}$$

1.2/ Spectral emission lines

$$\boxed{\mathcal{E} = hf_{mn} = \frac{hc}{\lambda_{mn}} = E_m - E_n} \; (eV)$$

$E_n \equiv E_1$: Lyman series

$E_n \equiv E_2$: Balmer series

E_3 : Paschen series

E_4 : Bracket series

2/ The Schrödinger Equation for the Hydrogen Atom.

The potential energy:

$$U(r) = -\frac{1}{4\pi\varepsilon_0} \cdot \frac{e^2}{r}$$

Wave function for the ground state.

$$\psi(r) = \frac{1}{a^{3/2}\sqrt{\pi}} \cdot e^{-r/a}$$

$a = 0,529 \times 10^{-10}$ m

for the 1st excited state:

$$\psi(r) = C \cdot e^{-ar/2}(2 - ar)$$

Probability: $P = \int_a^{+\infty} |\psi(r)|^2 dV$

$dV = 4\pi r^2 dr$

Quantization of Orbital Angular Momentum

$$L = \sqrt{\ell(\ell+1)} \cdot \hbar$$

$\ell = 0; 1; 2; \ldots n-1$: orbital angular-momentum quantum number or orbital quantum number.

$$L_z = m_\ell \cdot \hbar$$

$(m_\ell = -l, -l+1, -\ell+2; \ldots; 0; l-1; l)$

↳ orbital magnetic quantum number

vd: $n = 3 \to \ell = 0; 1; 2$

$\to m_\ell = -2; -1; 0; 1; 2$

CRABIT

$$= \frac{2}{L} \cdot \frac{L}{\pi} \int_{\pi/4}^{\pi/2} \sin^2 X \, dX$$

$$= \frac{2}{\pi} \cdot \frac{1}{2} \left(X - \frac{1}{2} \sin 2X \right) \Big|_{\pi/4}^{\pi/2}$$

$$= \frac{1}{\pi} \left(\frac{\pi}{4} + \frac{1}{2} \right)$$

$$= \frac{1}{4} + \frac{1}{2\pi}$$

$l = 0$: s state   3 : f

1 : p states   4 : g

2 : d   5 : h

$n = 2 \rightarrow$ 4 states $\rightarrow$ degeneracy $g = 4$

Electron spin

spin angular momentum :

$$S = \sqrt{s(s+1)}\,\hbar = \frac{\sqrt{3}}{2}\hbar \quad \left(s = \frac{1}{2}\right)$$

$$S_z = m_s \hbar = \pm \frac{\hbar}{2} \quad \left(m_s = \pm \frac{1}{2}\right.$$

magnetic spin number

2/ The Schödinger Equation for the Hydrogen Atom.

potential energy : $U(r) = -\frac{1}{4\pi\varepsilon_0} \cdot \frac{e^2}{r}$

~~angular between~~ angle between L and the z-axis :

$$\cos\theta = \frac{L_z}{L}$$

$$\sqrt{L_x^2 + L_y^2} = \sqrt{L^2 + L_z^2}$$

Chapter 5

A. Special theory of ~~relatively~~ relativity

1> Einstein's Postulates.

1.2> Second postulates

$$\Delta t = \frac{\Delta t_0}{\sqrt{1 - \frac{u^2}{c^2}}}$$

$$L = L_0 \sqrt{1 - \frac{u^2}{c^2}}$$

$$m_{rel} = \frac{m}{\sqrt{1 - \frac{u^2}{c^2}}}$$

Chapter 5

Relativity and Nuclear Physics

Einstein's Postulates

Time dilation: $\Delta t = \dfrac{\Delta t_0}{\sqrt{1 - \frac{v^2}{c^2}}}$ $(\Delta t > \Delta t_0)$

Length contraction: $L = L_0 \sqrt{1 - \frac{v^2}{c^2}}$ $(L < L_0)$

Kinetic dynamics: m_0: rest mass

$m_{rel} = m_0 \dfrac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$: relativistic mass

Rest energy: $E_0 = mc^2$

total energy: $E = E_0 + k = m_{rel} . c^2$

Nuclear Physics

$${}^{A}_{Z}X$$

A → mass number

Z → ~~m~~ number of proton

$A = Z + N$

radii of most nuclei: $R = R_0 . A^{1/3}$ $(R_0 = 1{,}2 \times 10^{-15} m)$

Binding energy

$$E_B = (Z . m_p + N . m_n - {}^{A}_{Z}M) . c^2 \text{ MeV}$$

$c^2 = 931{,}5$ MeV/u

Reaction energy: $A + B \rightarrow C + D$

$$Q = \underbrace{(M_A + M_B - M_C \mp M_D)}_{\Delta M:\ \text{mass defect}} . c^2 \text{ MeV}$$

độ hụt khối

~~$E = \Delta M c^2$~~

$\alpha : {}_{2}^{4}He$

$\beta^- : {}_{-1}^{0}e$

$\beta^+ : {}_{1}^{0}e$

Decay rate:

$N(t) = N_0 . e^{-\lambda . t}$: number of nuclei in a sample at time t

$T_{1/2} = \frac{\ln 2}{\lambda}$: the half life

$T_{mean} = \frac{1}{\lambda}$: the life time

λ : decay constant.