I/ Questions de cours. A.M

1. Davisson - Germer / ou autre vu en TD.
2. Rayonnement corps noir / effet photoélectrique.
3. De Broglie $\boxed{p = h/\lambda_{DB}}$ λ_{DB} longueur d'onde de De Broglie

II/ 1. Champ électrique $\boxed{\vec{\mathcal{E}} = \mathcal{E}.\vec{e_z} \ (\mathcal{E}>0)}$ et Force électrostatique $\boxed{\vec{F} = -q\vec{\mathcal{E}}}$

2. $\boxed{\hat{H}\psi(z,t) = i\hbar \frac{\partial}{\partial t}\psi(z,t)}$ $\boxed{\psi(z,t) = \varphi(z)\, e^{-iEt/\hbar}}$ $\Rightarrow \boxed{\hat{H}\varphi(z) = E\,\varphi(z)}$

3. $\boxed{\hat{H} = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial z^2} + q\mathcal{E}z}$ $\Rightarrow \boxed{-\frac{\hbar^2}{2m}\cdot\frac{\partial^2}{\partial z^2}\varphi(z) + q\mathcal{E}z\cdot\varphi(z) = E\varphi(z)}$

4. $z \to \infty$ $V(z) \Rightarrow \infty$ donc $\boxed{\varphi(\infty) = 0}$ et $z \leq 0$ $V(z) \to \infty \Rightarrow \boxed{\varphi(0) = 0}$

5. $\frac{\partial^2}{\partial z^2}\cdot\varphi(z) + q\mathcal{E}\times\frac{2m}{\hbar^2}\cdot z\,\varphi(z) = \frac{2m}{\hbar^2}\cdot E\varphi(z)$ et $z = z_0\alpha$. $\Rightarrow$

$\frac{1}{z_0^2}\cdot\frac{\partial^2}{\partial\alpha^2}\varphi(\alpha) + q\mathcal{E}\,\frac{2m}{\hbar^2}\cdot z\,\varphi(z) = \frac{2m}{\hbar^2}\cdot E\varphi(z) \Rightarrow \varphi''(\alpha) + q\mathcal{E}\cdot\frac{2m}{\hbar^2}\cdot z_0^2 \times z\,\varphi(\alpha) = \frac{2mE}{\hbar^2}\cdot z_0^2\varphi$

$\varphi''(z) + q\mathcal{E}\cdot\frac{2m}{\hbar^2}\cdot z_0^3\alpha\,\varphi(\alpha) = \frac{2m}{\hbar^2}\cdot z_0^2\cdot E_0\,\beta\,\varphi(\alpha) \Rightarrow \boxed{z_0 = \left(\frac{2m}{\hbar^2}\cdot q\mathcal{E}\right)^{-1/3}}$ et

$E_0 = \frac{\hbar^2}{2m}\cdot\frac{1}{z_0^2} \Rightarrow E_0 = \frac{\hbar^2}{2m}\cdot\left(\frac{2m}{\hbar^2}\cdot q\mathcal{E}\right)^{2/3} = \boxed{\left(\frac{\hbar^2}{2m}\cdot q^2\mathcal{E}^2\right)^{1/3}}$

6. $-\frac{\partial^2\varphi(\alpha)}{\partial\alpha^2} + \alpha\,\varphi(\alpha) = \beta\,\varphi(\alpha) \Rightarrow \frac{\partial^2\varphi(\alpha)}{\partial(\alpha-\beta)^2} - (\alpha-\beta)\varphi(\alpha) = 0$; $\delta = \alpha - \beta \Rightarrow$

$\boxed{\frac{\partial^2 u(\delta)}{\partial\delta^2} - \delta.u(\delta) = 0}$ NON DEMANDÉE $\quad u(\delta) = \varphi(\alpha)$.

conditions aux limites $\varphi(z\to\infty) = 0 \Rightarrow \varphi(\alpha\to\infty) = 0 \Rightarrow \boxed{u(\delta\to\infty) = 0}$

et $\varphi(z=0) = 0 \Rightarrow \varphi(\alpha=0) = 0 \Rightarrow \boxed{\varphi(-\beta) = 0}$

7. $u(\delta) = 0 \Rightarrow u(-\beta) = 0 \Rightarrow -\beta_1 = -2{,}338$; $-\beta_2 = -4{,}088$; $-\beta_3 = -5{,}521$.

$\Rightarrow \boxed{E_1 = 2{,}338\,E_0}$; $\boxed{E_2 = 4{,}088\,E_0}$; $\boxed{E_3 = 5{,}521\,E_0}$

8. * $\Delta E_{12} = E_2 - E_1 = (4{,}088 - 2{,}338)E_0 \Rightarrow \boxed{\Delta E_{12} = 1{,}750\,E_0} \simeq \boxed{17{,}2 \text{ meV}}$

$E_0 = \left(\frac{(1{,}05.10^{-34})^2 \cdot (1{,}6.10^{-19})^2 \times (5.10^6)^2}{2\times 9.10^{-31}}\right)^{1/3} = \boxed{1{,}57.10^{-21}\text{ J}} = 9{,}85.10^{-3}\text{ eV} \simeq \boxed{10 \text{ meV}}$

* $\Delta E_{12} = h\nu_{12} = \frac{hc}{\lambda_{12}} \Rightarrow \lambda_{12} = \frac{hc}{\Delta E_{12}} = \frac{6{,}02.10^{-34}\times 3.10^8}{1{,}57.10^{-21}\times 1{,}750} = 7{,}23.10^{-5}\text{ m} = \boxed{72{,}3\,\mu m}$

9. $z_0 = \left(\frac{2m}{\hbar^2}\cdot q\mathcal{E}\right)^{-1/3} = \left(\frac{2\times 9.10^{-31}\times 1{,}6.10^{-19}\times 5.10^6}{(1{,}05.10^{-34})^2}\right)^{-1/3} = 1{,}97.10^{-9}\text{ m} \simeq \boxed{2.\text{nm}}$

10. $V_{ele} = q\mathcal{E}z$; $V_{grav} = mgz$ remplacer $q\mathcal{E}$ par $mg \Rightarrow E_0 = \left(\frac{\hbar^2}{2m}\cdot m^2 g^2\right)^{1/3} = \boxed{\left(\frac{\hbar^2 m g^2}{2}\right)^{1/3}}$

$E_0 = \left[\frac{(1{,}05.10^{-34})^2 \times 1{,}675.10^{-27}\times 9{,}8^2}{2}\right]^{1/3} = \boxed{9{,}6.10^{-32}\text{ J} = 6.10^{-13}\text{ eV}}$

$\boxed{E_1 = 2{,}338\times 6.10^{-13}\text{ eV} = 1{,}4.10^{-12}\text{ eV}}$; $\boxed{E_2 = 2{,}45.10^{-12}\text{ eV}}$; $\boxed{E_3 = 3{,}31.10^{-11}\text{ eV}}$