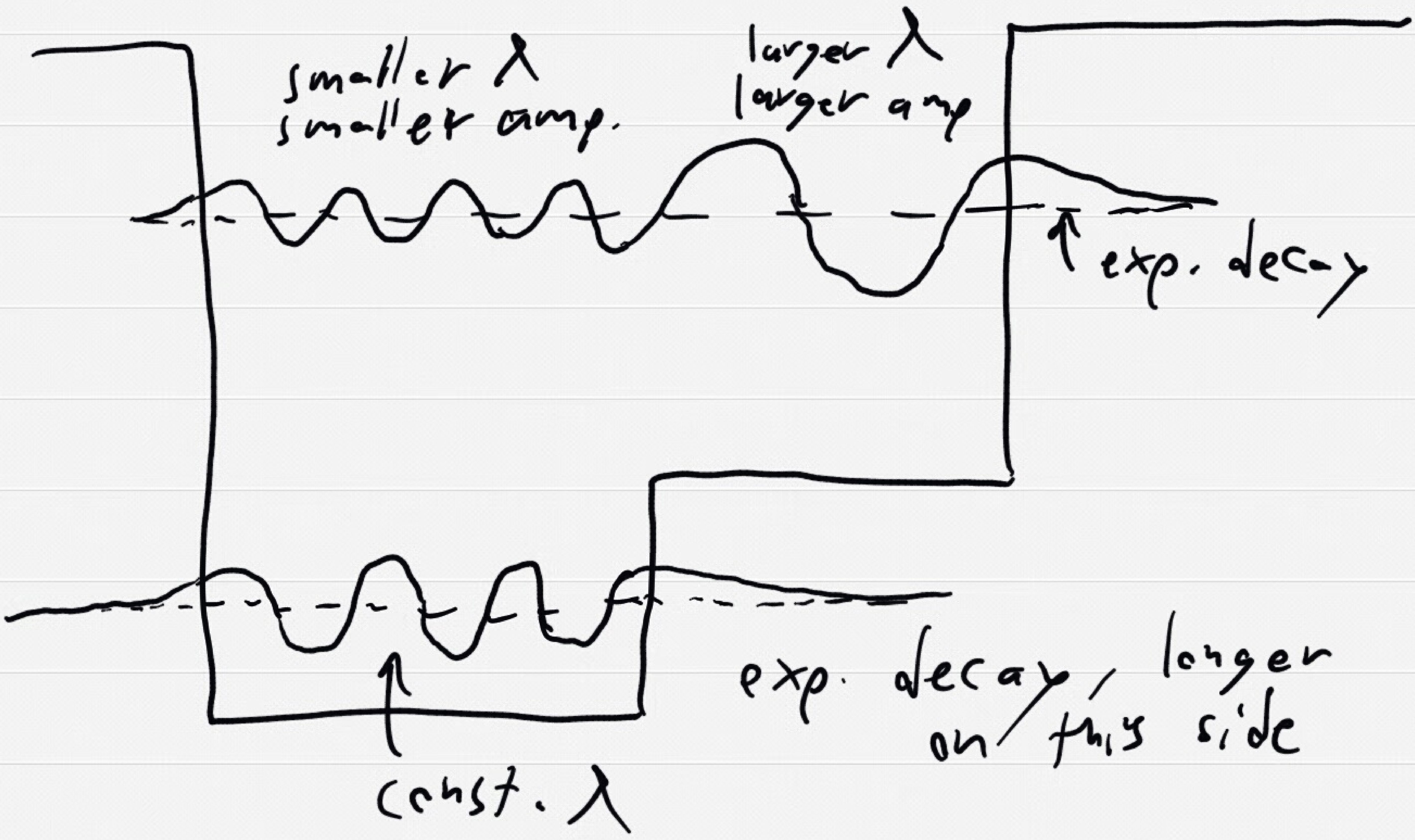
1.



2. a. $\psi_1 = A e^{ik_1 x} + B e^{-ik_1 x}$

$$\partial^2/\partial x^2 \, e^{\pm i k_1 x} = -k_1^2 e^{\pm i k_1 x}$$

so $\frac{\hbar^2 k_1^2}{2m} = E$ or $\boxed{k_1 = \sqrt{\frac{2mE}{\hbar^2}}}$

b. $\psi_2 = C e^{-k_2 x}$

$$\partial^2 \psi_2 / \partial x^2 = k_2^2 \psi_2$$

$\Rightarrow \frac{\hbar^2 k_2^2}{2m} = U_0 - E$

or $\boxed{k_2 = \sqrt{2m(U_0 - E)/\hbar^2}}$

c. $\partial \psi / \partial x$, ψ continuous

$$\Rightarrow \boxed{\begin{aligned} A + B &= C \\ ik_1(A - B) &= -k_2 C \end{aligned}}$$

3. Closest approach for $b = 0$ when $K = U$

or $K = \frac{zZe^2}{4\pi\varepsilon_0 r} \Rightarrow r = \frac{zZe^2}{4\pi\varepsilon_0 K}$

so $r \propto Z$, inv. $\propto K$

$$\boxed{r_{min} = 12.5 \text{ fm}}$$

4. a. $r^2 R^2 = A^2 \frac{r^6}{a_0^7} e^{-2r/3a_0}$

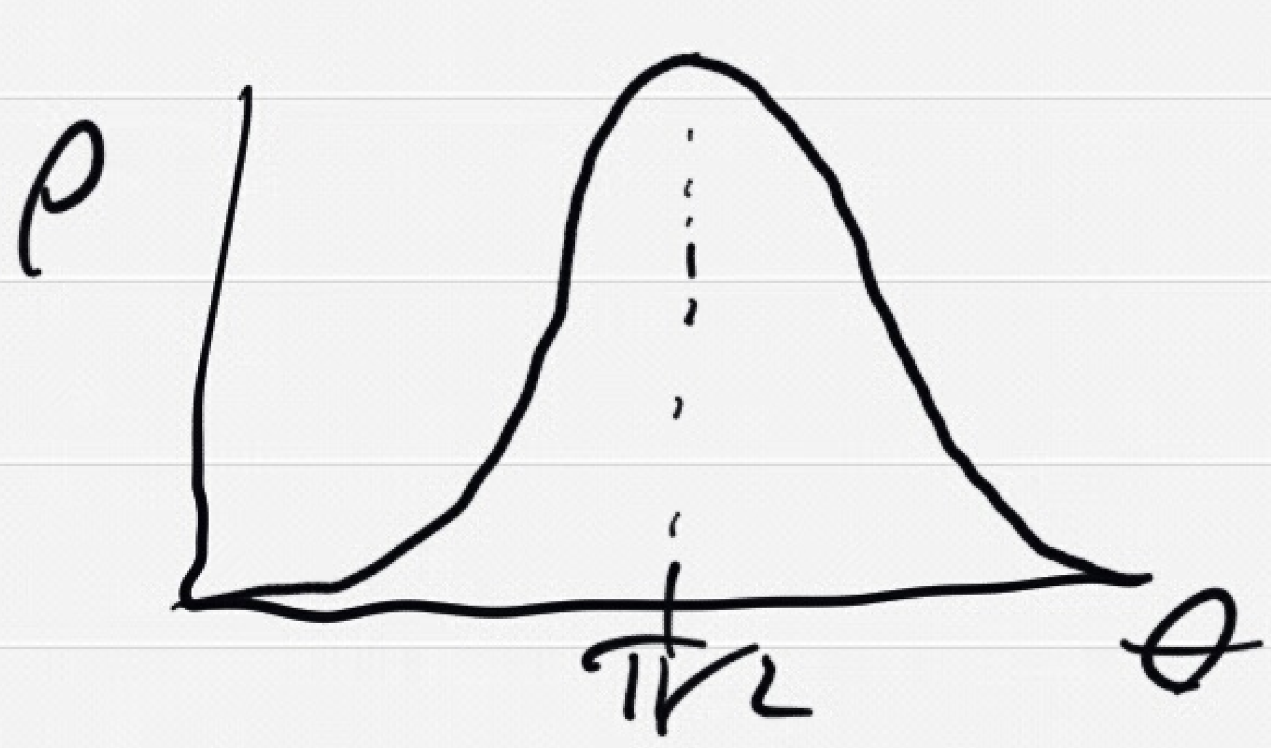
$$\frac{d}{dr}(r^2R^2) = \frac{A^2}{a_0^7}\left(6r^5 e^{-2r/3a_0} - \frac{2}{3a_0} r^6 e^{-2r/3a_0}\right)$$

$= 0$ if $2r/3a_0 = 6$

or $\boxed{r = 9a_0}$

b. $|\psi|^2 \propto \sin^4\theta \, e^{2i\varphi} e^{-2i\varphi}$

$= \sin^4\theta$



L mostly in z-direction since orbit mostly @ $\theta = \pi/2$ (in x-y plane)

5. Electrons can briefly borrow energy to pass barrier if allowed by uncertainty principle.

shorter and narrower barriers easier to pass since ΔE less and Δt less.