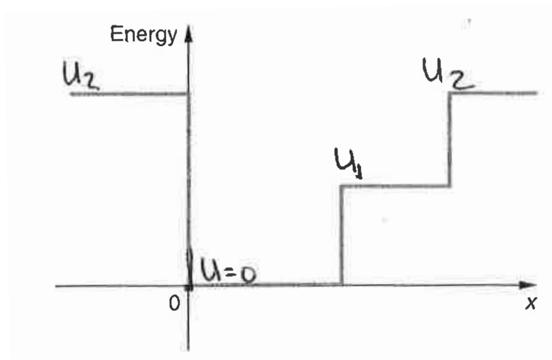
Modern Physics
Problem Set 9

JC-42) **Electron in a Finite Well**
(10 points) An electron is trapped in a finite well. How far (in eV) is it from being free if the penetration length of its wave function into the classically forbidden region is 1 nm?

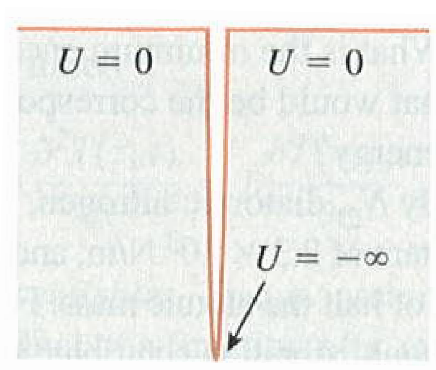
JC-43) **Wave Function of Particle in a Finite Well**
(10 points) Below is a sketch of a potential well. Sketch a plausible wave function for a particle with $U_1 < E < U_2$ paying close attention to curvature, wavelength and amplitude of the wave function. Explain why the wavelength and amplitude of the wave function vary as they do.



JC-44) **The Delta Well Potential**
Consider the delta well potential energy,

$$U(x) = \begin{cases} 0 & x \neq 0 \\ -\infty & x = 0 \end{cases}$$

Although not completely realistic, this potential energy is often a convenient approximation to a *very* strong, *very* narrow attractive potential energy well. It has only one allowed bound-state wave function, and because the top of the well is defined as $U = 0$, the corresponding bound-state energy is negative. Let this bound state have a value $-E_0$.



(over)

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a) (20 points) Show that the wave function for this scenario is given by

$$\psi(x) = (\frac{2mE_0}{\hbar^2})^{1/4} e^{-(\sqrt{2mE_0}/\hbar)|x|}$$

Hint: The delta function is a spike of area 1. So, there are only two regions to consider, to the right and to the left of the spike. Write the wave function in each region (I and II) , use boundary conditions and normalization to solve for the amplitude.

b) (10 points) Sketch $\psi(x)$ and $U(x)$ on the same diagram. Does this wave function exhibit the expected behavior in the classically forbidden area?

Talk 1) **Detailed Outline**
(20 points) Produce a detailed outline of your talk. Reminder: Outlines must be typed.

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