Problem 1:
Finite quantum well

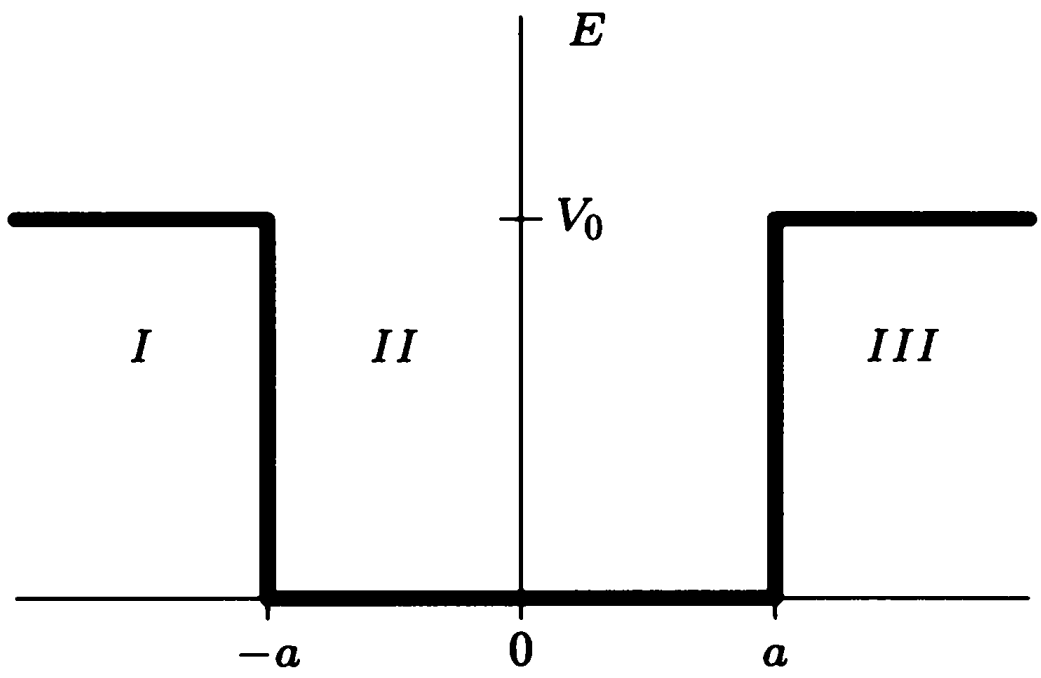


FIGURE 2.8 The finite square well.

$$\frac{d^2\psi}{dx^2} - \frac{2m}{\hbar^2}(V_0 - E)\psi = 0,$$ Schroedinger Equation

Analytical solution of the wave function

In region II the general solution is

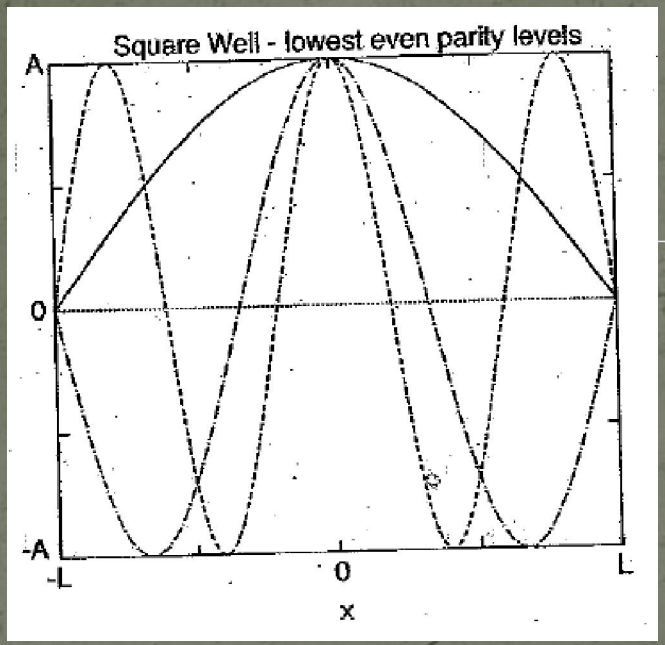
$$\psi_{II} = A \sin \alpha x + B \cos \alpha x, \qquad \alpha = \sqrt{\frac{2mE}{\hbar^2}},$$

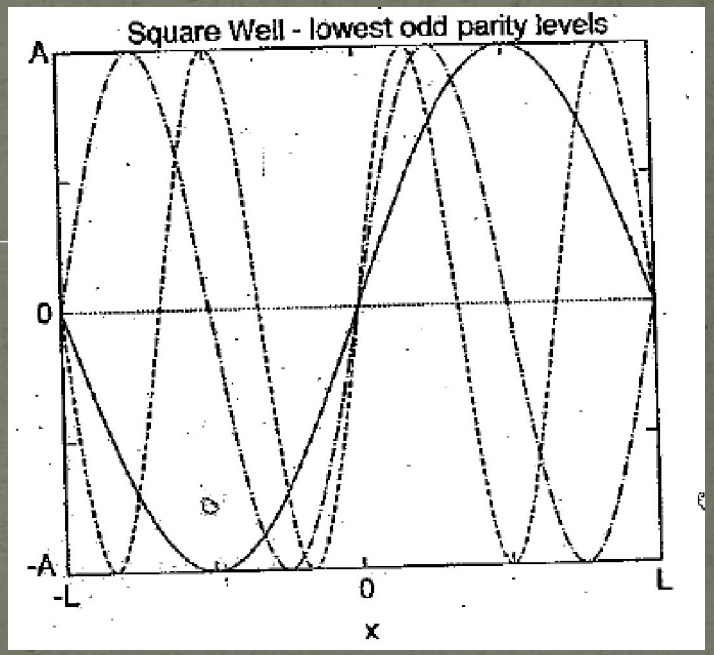
while in region III it must be

$$\psi_{III} = F e^{-\beta x}$$

How about ψ_I?

Old and Even solutions





Continuity at $x = -a$

$$-A\sin\alpha a + B\cos\alpha a = Ce^{-\beta a}$$

$$\alpha A\cos\alpha a + \alpha B\sin\alpha a = \beta Ce^{-\beta a},$$

Discontinuity at $x = a$

$$A\sin\alpha a + B\cos\alpha a = Fe^{-\beta a}$$

$$\alpha A\cos\alpha a - \alpha B\sin\alpha a = -\beta Fe^{-\beta a}.$$

Even States: $A = 0, \quad B \neq 0, \quad C = F, \quad \beta \cos \alpha a = \alpha \sin \alpha a.$

Odd States: $A \neq 0, \quad B = 0, \quad C = -F, \quad \alpha \cos \alpha a = -\beta \sin \alpha a.$

where $\alpha = \sqrt{\frac{2mE}{\hbar^2}}$ and $\beta = \sqrt{2m(V_0 - E)/\hbar^2}.$

Problems:

Plot the function

$$f(E) = \beta \cos \alpha a - \alpha \sin \alpha a$$

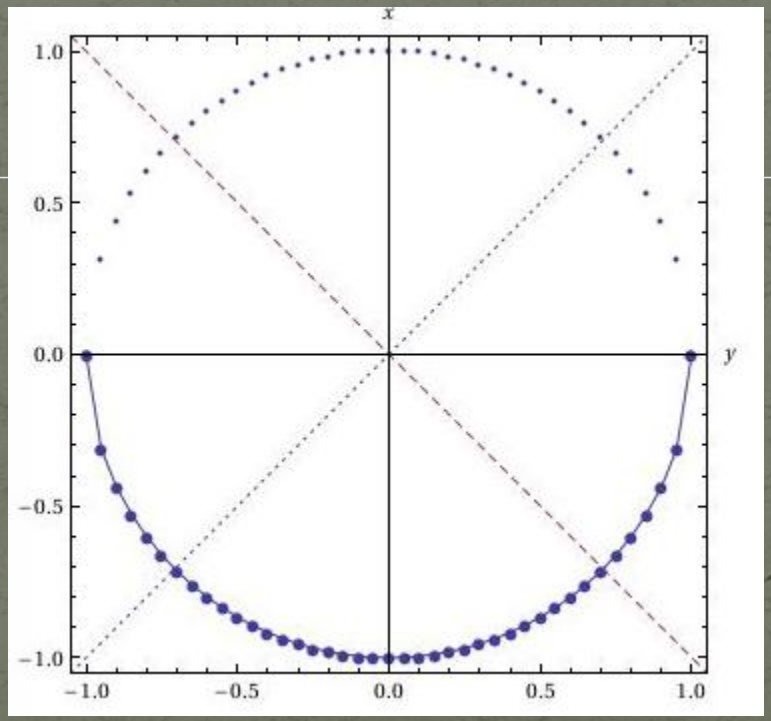
as a function of energy.

Given $V_0 = 10\ \text{eV}$, $a = 3\ \text{Å}$, and $m = 1\ m_e$

Find the lowest even and lowest odd solutions to the square well problem, with $a = 3$ Å, $m = 1\ m_e$, and $V_0 = 10$ eV. Plot the potential and the wavefunctions associated with these eigenvalues. (The convention is to align the zero baseline of the wavefunction with the energy eigenvalue.)

Problem 2

- The graph as shown is produced using Show[],Plot and ListPlot. The equation for a circle with unit radius is x^2 + y^2 = 1. Produce the graph.



Problem 3: Use (i) stochastic method, (ii) Simpson rule, (iii) trapezoid rule, (ii) Mathematica method to evaluate the area of a gaussian with mu = 0, sigma = 1, for *x* in [-0.5,0.5].

Problem 4: Find the root of e^x=-x+2 using the (i) bisection method, (ii) Newton-Raphson method, (iii) Mathematica method.

Problem 5: There are three roots in x sin =-1.5x+3. Write a programe to find all of them (use whatever method suit to your taste)