1 Problem Set 1

1. Compute the probability flux for a plane wave $\psi = \exp[i(px - Et)/\hbar]$. Does this result make sense?

2. We assume a potential energy well of the form

$$U = \begin{cases} 0, & |x| < a/2 \\ U_0, & |x| > a/2 \end{cases}$$

   for a particle of mass m. The wavefunctions are either symmetric or antisymmetric about $x = 0$ and bound state energies can range over $0 < E < U_0$.

   (a) Show that symmetric solutions must satisfy the condition

$$\tan(\kappa\epsilon^{1/2}) - (1/\epsilon - 1)^{1/2} = 0,$$

   where $\epsilon = E/U_0$ and $\kappa = a(2mU_0)^{1/2}/2\hbar$.

   (b) Tabulate the values of ϵ that satisfy the above equation for $\kappa = 0.1, 0.3, 1, 3, 10$. Use RLaB with the rfile **symmwell.r**, available in the demonstrations.

   (c) Find the corresponding condition for antisymmetric solutions and tabulate values of ϵ for the above values of κ.

3. Modify **shoot_demo.r** to find the allowed energies and wavefunctions for the potential $U = \kappa[1 - \exp(-x^2)]/2$, with $\kappa = 1, 3$.