Problems

Q1- A stationary state spatial wavefunction $\psi(x) = A\exp(ikx)$ represents a stream of particles. What is the number density of particles per unit length, the momentum of each particle, and the flux?

Ans: $p = \hbar k \quad \mathrm{P(x)} = |\mathrm{A}|^2, \quad \mathrm{F} = |\mathrm{A}|^2 \frac{\hbar k}{m}$

Q2- A beam of electrons with kinetic energy 5 eV is incident on a region where the electron potential energy suddenly increases from 0 to 2.5 eV. Calculate the transmission and reflection coefficients at this 'step'. Sketch the electron density as a function of position. Account for the sequence of maxima and minima before the step. Assume the potential is constant before and after the step

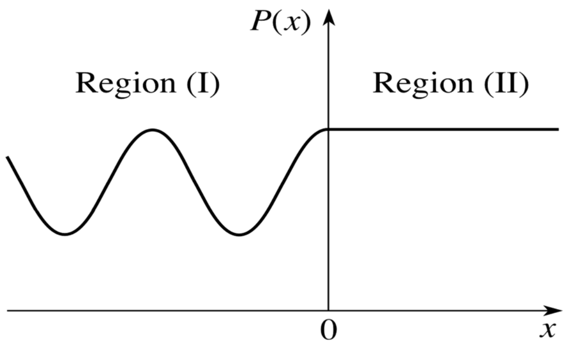
Q3-Write down the time–independent Schrödinger equation for a particle moving in one dimension (x) in a region of space where the total energy is less than the constant potential energy V. Show by substitution that the spatial wavefunction $\psi(x) = A\exp(-\alpha x) + B\exp(\alpha x)$, where A and B are constants, is a solution of this equation and find α in terms of E and V.

Q4-Electrons with kinetic energy 5 eV are moving in the positive x–direction in a region of constant potential. There are on average 5×10^6 electrons per millimetre. Find a suitable wavefunction

What is the flux of electrons?

What is the corresponding current in ampers?

Q5- The figure shows clearly that the probability per unit length of finding a particle in region (II) is greater, on average, than the probability in region (I). How can that be when a fraction of the incident particles is reflected?



Q6- For potential step E< V. Why does the density function have a maximum of four particles per unit length in region (I) when the incident particle density is one per unit length?

Q7-A beam of electrons of energy 5 eV approaches a potential step of height 10 eV. Assume there is on average one incident particle per unit length. Calculate the following:

(a) The average particle density at $x = 0$

(b) The point nearest the step where $P_1(x)$ is minimum

(c) The penetration depth D.