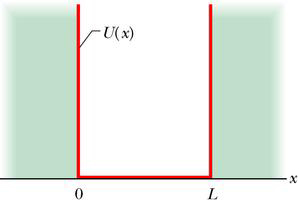
近代物理期中考

1. Consider an infinite potential as discussed in class, with boundaries at and : and .



A particle is known to be localized in middle of the box, with the instant wavefunction as:

Calculate the probabilities that at the instance the energy measurement yields the ground state energy , the energy of the first excited state and the second excited state .

解答：這樣就滿足邊界條件。我們就能預期可以以展開：。

1. Consider the wave packet-like state as described in Example 2-1 of P27, for which, , when and elsewhere. The wavefunction of this state is calculated in the textbook to be equal to:
2. The constant can be determined by the condition . Calculate .
3. Write the expressions for and show and This is not a good behaved state. Calculate the expectation values: .

Hint: 課本P39。

解答：

1. ，。
2. 期望值：

因為是奇函數的積分。

1. Consider an electron moving from left to right and is scattered by a step potential at . The step potential is: and .

A picture containing text, sky, map

Description automatically generated

A wave packet formulation of this scattering can be approximated by considering the stationary energy eigenfunction of this step potential. The solution is:

A picture containing diagram

Description automatically generated

Calculate the probability density as a function of in terms of at It is a constant at .

解答：。

1. The emission through a small hole of a cavity can simulate the blackbody radiation. In an imaginary world of 4 dimensional space, we assume there is a 4 dimensional cavity and everything else is the same.

Write down the cavity energy density with respect to frequency: . You need to describe how you get the answer. You don’t need to worry about constants but just show its dependence on and .

The total emission rate in this case will be proportional to What is ?

Hint: The standing wave in 4D cavity are determined by four natural numbers . In the space of , standing waves with frequency smaller than lie inside a 4D sphere of radius proportional to . The boundary of a 4D sphere is a 3D sphere and the volume of a 3-sphere is 。