

PHY 304, II-Semester 2023/24, Tutorial 5

8. March 2024

Work in the same teams as for assignments. Do “Stages” in the order below.

Discuss on your table. When all teams finished a stage, make sure all students at your table understand the solution and agree on one by using the board.

Stage 1 WKB ”approximation” for the particle in the square well potential

- (i) Use Eq. (7.127) of the lecture (WKB wavefunction for the classically allowed region), to recover exactly the known solutions for the infinite square well potential [Eq. (2.10)] for allowed energies and corresponding wavefunctions. Why is it expected to get the exact result in this case?
- (ii) Discuss why you cannot use the WKB quantisation condition Eq. (7.145) here, and explicitly check that this would give you the wrong result for the energy.

Stage 2 Wave scattering:

- (i) Make drawing of 1D, 2D and 3D quantum scattering scenarios, and qualitatively discuss what information can be contained in the scattering wavefunction in each case, and which information is fixed by conservation laws. Does it make sense to talk about scattering in ND with $N > 3$?
- (ii) Discuss in your team the physical meaning (as opposed to mathematical definition), of “scattering angle“, “scattering amplitude“, “differential cross section“, “total cross section” and “partial wave amplitude”.
- (iii) Follow this link: <https://physics.weber.edu/schroeder/software/> and then start the app “Quantum Scattering in Two Dimensions”. Read the description, switch ‘Barrier type’ to “Circle” (or “Square”), and then do numerical experiments with sliders “Packet energy”, “Strength”, “Size”, “Softness”, to make contact with as many concepts from the lecture as possible. [*Important note: STOP the simulation once any wave hits the outer edge of the box, it becomes nonsense afterwards*] Discuss whether and how you can see
 - The structure of the scattering state (8.8) discussed in the lecture.
 - Interference
 - Momentum dependence of scattering
 - Others?

You may get back to this applet after doing assignment 5Q3, which provides you with a very similar code.

Stage 3 Revisit mid-sem exam: Look again at the mid-sem exam and do any question that you did not have time to do, were not sure about, or think you did badly. Only this time, it is open book and teamwork.