PHYS2063 Wave Physics Homework #23 Due Tuesday 29 Nov 2022

This homework assignment is due at the start of class on the date shown. You may submit a PDF of your solutions to the Canvas page for the course, or bring a paper copy to class.

(1) In class we studied the expectation value of position with an infinite-square-well wave function $u(x)$ that was equal parts $u_1(x)$ and $u_2(x)$ with real coefficients. Recalculate this expectation value with a similar wave function, but which has an arbitrary phase between $u_1(x)$ and $u_2(x)$, namely

$$u(x) = \frac{1}{\sqrt{2}} \left[u_1(x) + e^{i\phi} u_2(x) \right]$$

Confirm that you get the same result we had in class for $\phi = 0$. You should find the integral we did in class useful.

(2) Now calculate the ime dependent expectation value of position for an equal superposition of $\psi_1(x,t) = u_1(x)e^{-iE_1 t/\hbar}$ and $\psi_2(x,t) = u_2(x)e^{-iE_2 t/\hbar}$. You should find the results of Problem (1) useful. How would you describe the behavior of the particle in the well, briefly?

(3) In class we worked through the numerical calculation of the finite square well with

$$V_0 = g \frac{\hbar^2}{2ma^2}$$

with a "very deep well" namely $g = 100$. Repeat the calculation for an extremely deep well with $g = 1000$, and compare the bound state energies with the results for an infinitely deep well. You are welcome to adapt the MATHEMATICA notebook we used in class.