Computational Physics II
Quiz 2

UCSD PHYS 142/242
Due: Friday, January 17, 2025, 8:00pm

Policies

Please work on the quiz individually.

Submission Instructions

Please submit your quiz as a single .pdf file to Gradescope under "Quiz 2".

1 Propagator and Schrödinger Equation [20 Points]

Relevant materials: Week 2 lectures

Problem A [10 points]: Prove that the free particle propagator

$$\mathcal{K}(x_B, t_B; x_A, t_A) = \left(\frac{m}{2\pi i\hbar(t_B - t_A)}\right)^{1/2} \exp\left[\frac{im(x_B - x_A)^2}{2\hbar(t_B - t_A)}\right] \tag{1}$$

satisfies the Schrödinger equation

$$-\frac{\hbar}{i}\frac{\partial \mathcal{K}(x_B, t_B; x_A, t_A)}{\partial t_B} = -\frac{\hbar^2}{2m}\frac{\partial^2 \mathcal{K}(x_B, t_B; x_A, t_A)}{\partial x_B^2} \tag{2}$$

by direct substitution.

Hint: *Without loss of generality, you can set* $x_A = t_A = 0$.

Problem B [10 points]: Using the above, show that any wave function $\psi(x, t)$ of a free particle also satisfies the Schrödinger equation

$$-\frac{\hbar}{i}\frac{\partial \psi(x, t)}{\partial t} = -\frac{\hbar^2}{2m}\frac{\partial^2 \psi(x, t)}{\partial x^2}. \tag{3}$$

Hint: *Use the fact that* $\psi(x, t) = \int_{-\infty}^{\infty} \mathcal{K}(x, t; x', t')\psi(x', t')dx'$.