**Problem 2:** (5 points)

Consider a particle of mass $m$ which moves inside an infinite one-dimensional box potential

$$V(x) = \begin{cases} \infty & x < -\frac{a}{2} \\ 0 & -\frac{a}{2} \leq x \leq \frac{a}{2} \\ \infty & x > \frac{a}{2} \end{cases}$$

Assume that the wave function of this particle is

$$\psi(x) = \begin{cases} 0 & x < -\frac{a}{2} \\ B \sin\left(\frac{2\pi x}{a}\right) e^{-iEt/\hbar} & -\frac{a}{2} \leq x \leq \frac{a}{2} \\ 0 & x > \frac{a}{2} \end{cases}$$

a)Find the energy of this particle.
b) Sketch the probability $P(x,t)$ for this particle.
c) Calculate $B$ so that $\psi(x)$ is normalized.
d) Evaluate $< x >$, $< p >$, $< x^2 >$ and $< p^2 >$.
e) Evaluate $\Delta x \Delta p$. Is this result compatible with the uncertainty principle?

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