Quiz #12 (Uncertainty Principle and Particle Current)

Prob.1(1)

A particle with mass M has the wave function given as $\psi(\overline{r},t) = \exp\left[i(\overline{k} \cdot \overline{r} - \omega t)\right]$.

What is $\hat{p}\psi(\overline{r},t)$, where $\hat{p}$ is the momentum operator.

Prob. 2(2)

An electron having mass M is in the lowest eigen state of a one-dimensional quantum well with width L and infinitely large barriers. What is the uncertainty for the momentum of this electron? For uncertainty estimation, use the standard deviation defined as sqrt[E(x^2) - E(x)^2], where E(x) represents the expected value of a random variable x.

Prob. 3(2)

A quantum mechanical particle with mass M and kinetic energy E is injected from left (V(x)=0 for x<0) into a potential barrier (V(x)= V_0 < E for x<0) at x = 0. How much of the injected particle current is transmitted into the right side? Give your answer in terms of V_0 and E.