

Physics 491: Quantum Mechanics 1  
 Problem Set #3: Solutions

Problem 1 Square packet

Initial plane wave  $\psi_0 e^{i p_0 x / \hbar}$  is localized in a region of width  $a$

$$\psi(x) = \begin{cases} A e^{i p_0 x / \hbar} & -\frac{a}{2} \leq x \leq \frac{a}{2} \\ 0 & \text{otherwise} \end{cases}$$

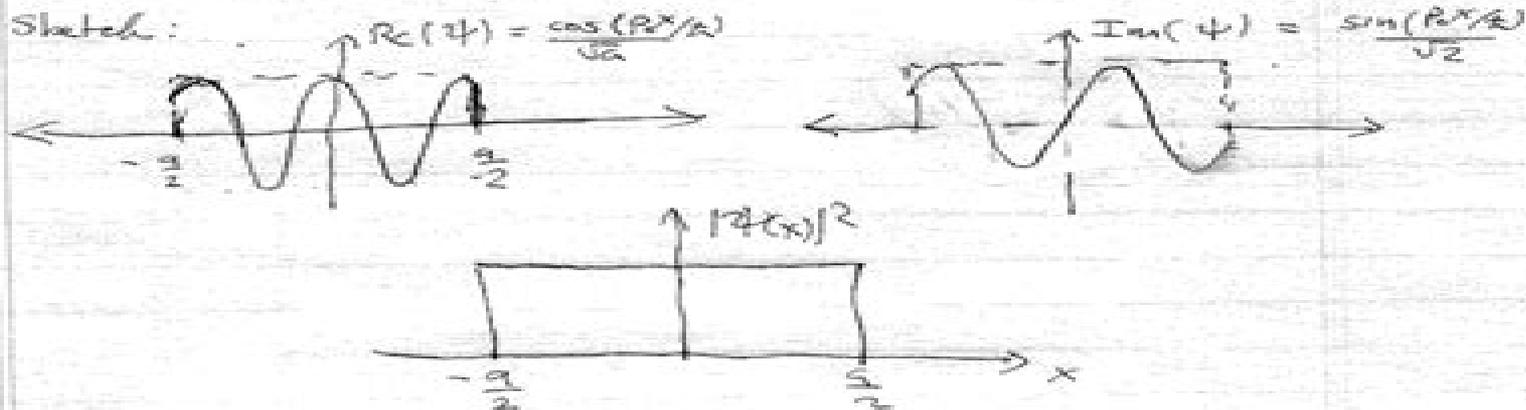
(a) Normalization  $\int_{-\infty}^{\infty} |\psi(x)|^2 dx = \int_{-a/2}^{a/2} dx |A|^2 = 1$

$\Rightarrow a |A|^2 = 1$

$\Rightarrow A = \frac{e^{i\phi}}{\sqrt{a}}$  ← overall phase is arbitrary (set  $\phi = 0$ )

$\Rightarrow \psi(x) = \frac{1}{\sqrt{a}} e^{i p_0 x / \hbar}, \quad -\frac{a}{2} \leq x \leq \frac{a}{2}$

Sketch:



Note that the probability density in "position space" does not depend on the momentum  $p_0$

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