

Physics 4610 Quantum mechanics  
Quiz 5

NAME: Key

At  $t = 0$ , the wave function of a free electron is given as

$$\psi(x, 0) = \frac{1}{2a} \quad -a \leq x \leq a$$
$$\psi(x, 0) = 0 \quad \text{otherwise}$$

where  $a$  is a positive constant.

- Find the Fourier amplitude of  $\psi(x, 0)$ .

$$\phi(k) = \frac{1}{\sqrt{2\pi}} \int \psi(x, 0) e^{-ikx} dx$$
$$= \frac{1}{\sqrt{2\pi}} \int_{-a}^a \frac{1}{2a} e^{-ikx} dx = \boxed{\frac{1}{\sqrt{2\pi}} \frac{1}{a} \frac{\sin ka}{k}}$$

- Write the expression for  $\psi(x, t)$ . Do not evaluate the integral for this part.

$$\phi(k) = \frac{1}{\sqrt{2\pi}} \frac{1}{a} \frac{\sin ka}{k}$$
$$\psi(x, t) = \frac{1}{2\pi a} \int \frac{\sin ka}{k} e^{ikx} \cdot e^{-i\frac{\hbar k^2}{2m} t} dk$$