

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DEPARTMENT OF PHYSICS

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Physics 212 – Quiz #5a
Chapter 5

Name: Key Id#: _____

An electron is confined to an infinite well of width 0.3 nm. The wave function of the electron is

$$\psi(x) = \sqrt{\frac{2}{L}} \sin\left(\frac{2\pi x}{L}\right)$$

- (a) What is the energy of the electron?
 (b) Calculate the probability of finding the particle between $x = 0$ and $x = L/4$.
 ($m_e = 9.1 \times 10^{-31}$ kg, $\hbar = 1.05 \times 10^{-34}$ J·s)

a) $\psi(x) = \sqrt{\frac{2}{L}} \sin(kx) \Rightarrow k = \frac{2\pi}{L}$

$$p = \hbar k = \frac{2\pi\hbar}{L} \quad K = \frac{p^2}{2m} = \frac{4\pi^2\hbar^2}{2mL^2}$$

$$= \frac{2\pi^2\hbar^2}{mL^2} = 2.66 \times 10^{-18} \text{ J}$$

$$= \boxed{16.6 \text{ eV}}$$

b) $P = \int_0^{\frac{L}{4}} \psi^2(x) dx = \frac{2}{L} \int_0^{\frac{L}{4}} \sin^2\left(\frac{2\pi x}{L}\right) dx$

$$= \frac{2}{L} \int_0^{\frac{L}{4}} \left[1 - \cos\left(\frac{4\pi x}{L}\right)\right] dx = \frac{1}{L} \left[x \Big|_0^{\frac{L}{4}} - \left(\frac{L}{4\pi}\right) \sin\left(\frac{4\pi x}{L}\right) \Big|_0^{\frac{L}{4}} \right]$$

$$= \frac{1}{L} \left[\frac{L}{4} - \frac{L}{4\pi} (\sin\pi - \sin 0) \right] = \frac{1}{4} = \boxed{25\%}$$