

# PH-214 Homework 7

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## Problem 1

$$\psi(x) = 4 * 3^{\frac{3}{2}} x e^{-6x} \quad \psi^* \psi = ||\psi||^2 = \boxed{432x^2 e^{-12x}}$$

This represents the probability of finding a particle at position  $x$

$$\frac{d}{dx}(\psi^* \psi) = 864x e^{-12x} - (432 * 12)x^2 e^{-12x}$$

$$x = 0, \boxed{0.167}$$

## Problem 2

$$\psi = e^{i(3x+2t)} \quad \psi^* = e^{-i(3x+2t)} \quad \psi^* \psi = 1$$

$$\int_{-\infty}^{\infty} \psi^* \psi \neq 1$$

Not a valid wave function.

## Problem 3

$$\lambda = \frac{h}{m_e v} \quad m_e = 9.11 * 10^{-31} \text{ kg} \quad h = 6.62 * 10^{-34} \text{ m}^2 \frac{\text{kg}}{\text{s}} \quad v = \sqrt{\frac{1}{m_e} * 2 * KE} \quad KE = 10 \text{ eV}$$
$$v = 4.68 * 10^{15} \frac{\text{m}}{\text{s}} \quad \lambda = \frac{6.62 * 10^{-34}}{9.11 * 10^{-31} * 4.68 * 10^{15}} = \boxed{1.55 * 10^{-19} \text{ m}}$$

## Problem 4

$$\frac{1}{\lambda} = R \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \quad R = 1.09 * 10^7 \quad n_1 = 2 \quad \lambda = 658.3 * 10^{-9}$$
$$-\frac{1}{\lambda R} + \frac{1}{n_1^2} = \frac{1}{n_2^2} \quad \frac{1}{n_2^2} = 0.11 \quad n_2 = \boxed{3}$$

## Problem 5

$$-\frac{\hbar^2}{2m} \frac{\partial^2 \psi}{\partial x^2} + V_0 \psi = E \psi \quad \hbar = 1.05 * 10^{-34} \quad \psi = e^{-ikx}$$

$$k^2 = -\frac{2m}{\hbar^2} (E - V_0)$$