Homework Assignment #9

Chapter 5 The Schrodinger Equation

Modern Physics:

Due Date: Thursday, March 30, 2017

In these problems, when the problem asks for mass, energy, and momentum, please write your answers in units of:

Mass $\rightarrow MeV/c^2$ not kilograms !!

Momentum $\rightarrow MeV/c$ not kilograms·meters/sec !!

Energy $\rightarrow MeV$ not joules !!

unless otherwise specified.

When you are asked for velocities, always quote your answers in units of "c," the speed of light.

velocity = $\boldsymbol{\beta}$ c

Problem 1: A free electron (P.E. = 0) has a wavefunction

$$\psi(x) = A\ sin(5.00 \times 10^{10}\ x)$$

where *x* is measured in meters. Find (1) the electron's de Broglie wavelength, (b) the electron's momentum, and (c) the electron's energy in electron volts.

Problem 2: The nuclear potential that binds protons and neutrons in the nucleus of an atom is often approximated by a square well. Imagine a proton confined in an infinite square well of length 10^{-5} nm, a typical nuclear diameter. Calculate the wavelength and energy associated with the photon that is emitted when the proton undergoes a transition from the first excited state ($n = 2$) to the ground state ($n = 1$).

In what region of the electromagnetic spectrum does this wavelength belong?

Problem 3: Consider the Gaussian wavefunction:

$$\psi(x) = A\ e^{-x^2/a^2}\ e^{-ikx}$$

Assume that this wavefunction extends over all space ($-\infty < x < \infty$). Calculate its normalization constant A.