Physics 214: Introduction to Quantum Mechanics
Spring 2013

Exam 1

Date: Friday, 22 February 2013

Instructions: This is a closed book exam. You are permitted to prepare a 1 page formula sheet (8.5 × 11” front and back) for reference during the exam. The list of constants and conversion factors from the textbook has been provided on the back of this cover page, which can be detached for your convenience. You have up to 2.5 hours to complete your solutions.

The point value of each problem is indicated, and the total is 50 points. In budgeting your time, you may wish to skim the exam to note the point value of each problem.

Show all your work in the blue books provided. Please number your blue books and write your name and the total number of blue books that you’ve used on each. Return your blue books together with your formula sheet. This exam is due at the start of class on Friday 1 March 2013.
Constants and conversion factors

Planck’s constant \( h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s} = 4.136 \times 10^{-15} \text{ eV} \cdot \text{s} \)

\( \hbar = h/(2\pi) = 1.055 \times 10^{-34} \text{ J} \cdot \text{s} = 6.582 \times 10^{-16} \text{ eV} \cdot \text{s} \)

Speed of light \( c = 2.998 \times 10^8 \text{ m/s} \)

Planck’s constant \( \times \) speed of light \( hc = 1240 \text{ eV} \cdot \text{nm} \)

Elementary charge \( e = 1.602 \times 10^{-19} \text{ C} \)

Fine-structure constant \( \alpha = e^2/(4\pi\epsilon_0hc) = 7.297 \times 10^{-3} = 1/137.036 \)

Boltzmann constant \( k_B = 1.381 \times 10^{-23} \text{ J/K} = 8.617 \times 10^{-5} \text{ eV/K} \)

Avogadro constant \( N_A = 6.022 \times 10^{23} \text{ particles/mole} \)

Electron mass \( m_e = 9.109 \times 10^{-31} \text{ kg} = 0.5110 \text{ MeV/c}^2 \)

Proton mass \( m_p = 1.673 \times 10^{-27} \text{ kg} = 938.3 \text{ MeV/c}^2 \)

Neutron mass \( m_n = 1.675 \times 10^{-27} \text{ kg} = 939.6 \text{ MeV/c}^2 \)

Bohr radius \( a_0 = 4\pi\epsilon_0\hbar^2/(m_e e^2) = 0.5292 \times 10^{-10} \text{ m} \)

Rydberg energy \( hcR_\infty = m_e c^2 \alpha^2/2 = 13.61 \text{ eV} \)

Bohr magneton \( \mu_B = e\hbar/(2m_e) = 5.788 \times 10^{-5} \text{ eV/T} \)

\[ 1 \text{ keV} = 10^3 \text{ eV} \quad 1 \text{ MeV} = 10^6 \text{ eV} \quad 1 \text{ GeV} = 10^9 \text{ eV} \quad 1 \text{ TeV} = 10^{12} \text{ eV} \]

\[ 1 \mu\text{m} = 10^{-6} \text{ m} \quad 1 \text{ nm} = 10^{-9} \text{ m} \quad 1 \text{ pm} = 10^{-12} \text{ m} \quad 1 \text{ fm} = 10^{-15} \text{ m} \]

\[ 1 \text{ eV} = 1.602 \times 10^{-19} \text{ J} \quad 1 \text{ Å} = 0.1 \text{ nm} = 10^{-10} \text{ m} \]