

PHY-851 QUANTUM MECHANICS I

Homework 5, 40 points

October 1 - 8, 2003

Uncertainty relation.

Reading: *Messiah*, Chapter II-V.

1. /5/ *Messiah*, Problem 1, p. 212.
2. /15/ Consider a particle of mass m in the n^{th} stationary state in an impenetrable potential box of width a . Find
 - a. the distribution function of particle coordinates;
 - b. the distribution function of particle momenta;
 - c. the mean values of the coordinate and momentum;
 - d. the mean square fluctuations of the coordinate and momentum.
 - e. Check the uncertainty relation.
 - f. Find mean kinetic energy and its mean square fluctuation.
3. /8/ An initial state of a free moving particle is described by the Gaussian wave packet of Problem 4, *Messiah*, p. 160, **see Homework 4**. Find the wave function at time $t > 0$ and dependence on time for mean values of the coordinate, momentum, their mean square fluctuations, and uncertainty relation.
4. /12/ Consider a particle of mass m in the gravitational field of the Earth (the surface is treated as an impenetrable plane).
 - a. Using the uncertainty relation, estimate energy and average height above the Earth for the ground state of the particle.
 - b. Give numerical estimates for the neutron.
 - c. For the electron one needs to consider in addition the electrostatic effects. Assume that the Earth is a perfect conductor and calculate the average height of the electron above the Earth in the ground state.