

Quantum Mechanics Summer 2003- Homework Set 1

Due at beginning of class July 7, 2003.

Cohen-Tannoudji Problems - in K_I

- 1 (Parts a and b only)
- 2 Skip doing the matrix stuff in part b.
- 3
- 5
- 6 Just solve the problem as given, don't worry about mapping it onto the symmetric square well.
- 7

Additional Problems

Problem A1 A particle begins to behave quantum mechanically when its de Broglie wavelength is of the same order as the size of the object with which the particle interacts. A good test is when the de Broglie wavelength is the same order as the size of the object. What mass does a spit ball with the density of water ($1000\text{kg}/\text{m}^3$) moving at $10\text{m}/\text{s}$ become quantum mechanical? How many atoms is this?

Problem A2 If this room is 5m square and your mass is 50kg , what is your minimum energy? If all this energy is kinetic, what is your minimum speed?

Problem A3 Rework the infinite square well, with width L . Write the normalized ground state wave function. Calculate the $\langle x \rangle$ and $\langle \Delta x \rangle$. Calculate the momentum probability density. Calculate the $\langle p \rangle$ and $\langle \Delta p \rangle$. Does Heisenberg hold?

Problem A4 What are your odds of jumping to the moon? Treat the earth's gravity as a square well such that the area of the well is equal to the work to move to the moon multiplied by the distance.

Problem A5 1 Angstrom is a good estimate of atomic size. Using equipartition of energy where $E = \frac{3}{2}kT$, calculate the temperature where the uncertainty in the location of a Helium atom, mass of approximately $4m_p$, is the same as the size of the atom.