PHY4604–Introduction to Quantum Mechanics

Fall 2004

Test 3

Dec. 3, 2004

No calculators or other materials. If you don’t recall a formula, ask and I might be able to help. If you can’t do one part of a problem, solve subsequent parts in terms of unknown answer—define clearly. Each part is worth 10 points, for max=70. Problem 1 required, attempt 1 of remaining 2 problems; circle which ones you want graded.

Possibly helpful formulae and constants

\[ P_n = |\langle n|\psi \rangle|^2 \quad H\psi = E\psi \]

\[ (PQ)\dagger = Q\dagger P\dagger \quad H\psi = i\hbar \frac{\partial}{\partial t}\psi \]

\[ \det(H - E) = 0 \quad \dot{\psi} = -i\hbar \nabla \psi \]

\[ 1 = \sum_n |n\rangle\langle n| \quad \psi(x) = \langle x|\psi \rangle \]

\[ E_n = -\left( \frac{m}{2\hbar^2} \left[ \frac{e^2}{4\pi \epsilon_0} \right]^2 \right)^{1/2} \int_0^\infty dy y^2 e^{-y} = 2 \]

\[ |\ell_1 - \ell_2| \leq \ell \leq /\ell_1 + \ell_2 \]

\[ a_0 = \frac{\hbar^2}{(Ze^2)} \]

\[ \psi(x,t) = e^{-iHt/\hbar}\psi(x,0) \]

\[ R_{10} = \frac{2}{\sqrt{4\pi a_0^3}} e^{-r/a_0} \]

\[ j = -\frac{i\hbar}{2m}(\psi^* \nabla \psi - \psi \nabla \psi^*) \]

\[ Y_{10} = \sqrt{\frac{3}{4\pi}} \cos \theta \]

\[ Y_{11} = \sqrt{\frac{3}{8\pi}} \sin \theta e^{i\phi} \]

\[ R_{21} = \sqrt{\frac{1}{3}} \left( \frac{1}{2a_0} \right)^{3/2} \frac{r}{a_0} e^{-r/2a_0} \]