

Homework Set A

Due Wednesday, September 3

1. A particle of mass m lies in one-dimension in a potential of the form $V(x) = Fx$, where F is constant. The wave function at time t is given by

$$\Psi(x, t) = N(t) \exp\left[-\frac{1}{2} A(t) x^2 + B(t) x\right]$$

where N , A , and B are all *complex* functions of time. Use Schrödinger's equation to derive equations for the time derivative of the three functions A , B , and N . You do not need to solve these equations.

2. For each of the wave functions in one dimension given below, N and a are positive real numbers. Determine the normalization constant N (in terms of a), and determine the probability that a measurement of the position of the particle will yield a result $x > a$.

(a) $\psi(x) = \frac{N}{x + ia}$

(b) $\psi(x) = N \exp(-|x|/a)$

(c) $\psi(x) = \begin{cases} Nx^2(x - 2a) & \text{for } 0 < x < 2a \\ 0 & \text{otherwise} \end{cases}$

3. An electron in the ground state of hydrogen has, in spherical coordinates, the wave function

$$\psi(r, \theta, \phi) = N e^{-r/a}$$

where N and a are positive constants. Determine the normalization constant N and the probability that a measurement of the position will yield $r > a$. Don't forget you are working in three dimensions!