

Quantum Mechanics I

Problem Set 8

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Due: Monday, March 14th 2016

Problem 8.1

Name or describe the following quantum mechanical symbols or expressions in a few buzz words each. If there is more than one meaning associated with an expression, mention them all.

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|------------------------------|----------------------------------------------------------------------------|
| (a) a | (g) S_z |
| (b) m | (h) V |
| (c) $H\psi = E\psi$ | (i) $\phi(p) = (2\pi\hbar)^{-3/2} \int e^{i(p\cdot r)/\hbar} \psi(r) d^3r$ |
| (d) σ_x | (j) l |
| (e) $\langle L^2 \rangle$ | (k) Y_2^2 |
| (f) $\int \Psi ^2 d^3r = 1$ | |

Problem 8.2

A spin- $\frac{1}{2}$ particle is prepared in the state

$$\chi = \frac{1}{\sqrt{3}} \begin{pmatrix} i+1 \\ 1 \end{pmatrix}.$$

- (a) What is the probability of finding the particle in a spin up state when you measure S_x , S_y or S_z ?
- (b) What are the expectation value of S_x , S_y and S_z ?
- (c) What are the uncertainties σ_{S_x} , σ_{S_y} and σ_{S_z} ?
- (d) Check if the uncertainty principle is satisfied:

$$\sigma_{S_x} \sigma_{S_y} \geq \frac{\hbar}{2} |\langle S_z \rangle|$$

Also check the other two permutations.

- (e) What is the probability of finding each of the particles in a spin up state of S_x after you measured S_z ? No calculation allowed.

Problem 8.3

Consider a spin-1 particle ($s = 1$). What values are allowed for m ? Construct the matrices S_x , S_y and S_z . Do it the same way we did it in the lectures for a spin- $\frac{1}{2}$ particle by looking at the action of S_z , S_+ and S_- on each state.

