

Physics 472 - 2020
Quantum Mechanics
Problem Set 3

1. Using the explicit form of the spherical harmonics $Y_l^m(\theta, \phi)$, Eq. (4.32) of the textbook, show that they are eigenfunctions of the parity operator and find the corresponding eigenvalues.
2. For the Pauli matrices $\sigma_{x,y,z}$, check the rule $\sigma_x\sigma_y = i\sigma_z$ and so on, in cycle. Check that the spin-1/2 matrices $s_i = (\hbar/2)\sigma_i$ obey the commutation relations for the angular momentum.
3. Construct the spin matrices S_x, S_y, S_z for a particle with spin 1.
4. Consider a spinor $\chi = \begin{pmatrix} a \\ b \end{pmatrix}$. Normalize it and find the expectation values of the spin components S_x, S_y , and S_z . Show that any matrix $A = \begin{pmatrix} \alpha & \beta \\ \gamma & \delta \end{pmatrix}$ can be written as a sum of the Pauli matrices and the unit matrix.

Each problem is 10 pt.