Assignment 9

The due date for submitting this assignment has passed.

As per our records you have not submitted this assignment.

Consider an electron in an external magnetic field \( \mathbf{B} \). The Hamiltonian \( \mathcal{H} \) is given by \( \mathcal{H} = -g \mu_B B \cdot \mathbf{S} \), where \( \mathbf{S} \) is the total spin operator and \( \mu_B \) is the Bohr magneton.

1. The identity matrix, \( \mathbf{1} \), in the representation of \( \mathbf{S}_z \) is

\[
\begin{bmatrix}
1 & 0 \\
0 & 1 \\
0 & 0 \\
0 & 0
\end{bmatrix}
\]

No. the answer is incorrect.

Answer Option: \( \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \)

2. The identity matrix in the representation of \( \mathbf{S}_x \) is

\[
\begin{bmatrix}
0 & 1 \\
1 & 0 \\
1 & 0 \\
0 & 1
\end{bmatrix}
\]

No. the answer is incorrect.

Answer Option: \( \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \)

Recall the problem of the quantum harmonic oscillator in the last assignment. We were told to evaluate the matrix elements of the density matrix in the position representation. Use your results to answer the following:

3. The expectation value \( \langle x^2 \rangle \) is

\[
\frac{\hbar^2}{2m}
\]

No. the answer is incorrect.

Answer Option: \( \frac{\hbar^2}{2m} \)

4. The expectation value \( \langle p^2 \rangle \) is

\[
\frac{\hbar^2}{2m}
\]

No. the answer is incorrect.

Answer Option: \( \frac{\hbar^2}{2m} \)

Consider a photon traveling along z and linearly polarized along \( \lambda \). Take the basis such that \( |1\rangle \) and \( |2\rangle \) are polarized along \( \lambda \) and \( \lambda' \), respectively.

5. The density matrix \( \rho \) is

\[
\begin{bmatrix}
0 & 0 \\
0 & 1
\end{bmatrix}
\]

No. the answer is incorrect.

Answer Option: \( \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} \)

6. \( |x_1\rangle \) and \( |y_2\rangle \) are respectively (Hint: One is a normalization, and one is a check for pure states.)

\[
0, 1, i, 1, i, 0, 0, 1
\]

No. the answer is incorrect.

Answer Option: \( 0, 1, i, 1, i, 0, 0, 1 \)