Assignment 3

Due on 2023-08-19, 09:00 AM

1. Calculate $x$ and $y$ in the equation $2x + 3y = 12$. Which is given in terms of these unknown variables $(x, y)$? of the Hamiltonian $H$ and unit $e^{i	heta}$. The expectation value is $\langle x \rangle = 3$.

   - $x = 3$
   - $y = 4$
   - $x = 6$
   - $y = 0$
   - None of these

2. Which of the following Fermi surfaces are not allowed to exist? (Unit 6)

   - $k = \frac{\pi}{2}$
   - $k = \frac{\pi}{4}
   - None of the above

3. The functional form of the equation of motion of relativistic electrons is given by the following equation:

   $$m \frac{d^2 \textbf{r}}{dt^2} + q \textbf{E}(\textbf{r}, t) = m \textbf{v}$$

   - True
   - False

4. Entangling with previous problem 3 in the context of spin state, the density matrix for this system $\rho$:

   - $\rho_{xx} = \frac{1}{2}$
   - $\rho_{yy} = \frac{1}{2}$
   - $\rho_{xy} = 0$
   - $\rho_{yx} = 0$
   - None of these

5. If the density matrix is given by the equation $\rho = \frac{1}{2} (I + \sigma_x)$, where $I$ is the identity matrix and $\sigma_x$ is the Pauli spin matrix.

   - True
   - False

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   - True
   - False

7. Find the density matrix $\rho$ for a spin-1/2 system in the state $|\uparrow\rangle$.

   - $\rho = \frac{1}{2} (I + \sigma_z)$
   - $\rho = \frac{1}{2} (I - \sigma_z)$
   - None of these

8. Calculate two different states with zero energy, $\epsilon = 0$ and hopping rate $\lambda = 1$. The change in bond energy changes the hopping rate $\lambda$.

   - True
   - False

9. The Hamiltonian is given by $H = \hbar \omega \sigma_z + \lambda (\sigma_x \otimes \sigma_x)$

   - True
   - False

10. Calculate the expectation value $\langle 0 | \sigma_z | 0 \rangle$ in the ground state $|0\rangle$ of the system.

   - $1$
   - $-1$
   - $0$

11. Which of the following represents the SEF for free electrons in one dimension subject to a magnetic field $B$ 1. $\langle A \mid B \rangle$ 2. $\langle A \mid 0 \rangle$ 3. $\langle 0 \mid B \rangle$

   - True
   - False

12. The function of state representation shows the SEF for free electrons in one-dimensional solid subject to a magnetic field $B$.

   - $\langle A \mid B \rangle$
   - $\langle A \mid 0 \rangle$
   - $\langle 0 \mid B \rangle$

   - True
   - False