

Advanced Quantum Physics

Quantum Physics · Answer Key · 8 Questions

1. Which phenomenon experimentally demonstrated the wave nature of matter, famously described by Louis de Broglie's hypothesis?

- A) The photoelectric effect
- B) Electron diffraction**
- C) Blackbody radiation
- D) Compton scattering

2. The Stern-Gerlach experiment is a cornerstone in quantum mechanics, primarily demonstrating which fundamental quantum property?

- A) Quantum entanglement
- B) Wave-particle duality of photons
- C) Quantization of angular momentum**
- D) Superposition of states

3. In quantum field theory, the concept of 'renormalization' is a technique used to address:

- A) The uncertainty principle
- B) Divergences in calculations of physical quantities**
- C) The spin-orbit coupling
- D) The probabilistic interpretation of wavefunctions

4. What is the fundamental distinction between bosons and fermions in terms of their statistical behavior?

- A) Bosons obey Maxwell-Boltzmann statistics, while fermions obey Fermi-Dirac statistics.
- B) Bosons obey Fermi-Dirac statistics, while fermions obey Bose-Einstein statistics.
- C) Bosons obey Bose-Einstein statistics, while fermions obey Fermi-Dirac statistics.**
- D) Bosons obey Maxwell-Boltzmann statistics, while fermions obey Bose-Einstein statistics.

5. The Berry phase, discovered by Michael Berry, is a geometrical phase that arises in:

- A) The study of entangled quantum states
- B) Adiabatic cyclic evolutions of quantum systems**
- C) The measurement of particle momentum
- D) The creation of entangled photon pairs

6. Which of the following is a direct consequence of the Pauli Exclusion Principle?

A) The stability of atoms

- B) The phenomenon of quantum tunneling
- C) The generation of Hawking radiation
- D) The existence of virtual particles

7. The Lamb shift, a small difference in energy between two energy levels in the hydrogen atom, was a crucial experimental observation that provided strong evidence for:

- A) The existence of quarks
- B) The validity of the Dirac equation alone

C) Quantum electrodynamics (QED)

- D) The spin-orbit interaction

8. In quantum mechanics, the expectation value of an observable is calculated by integrating the operator corresponding to the observable with:

- A) The Hamiltonian of the system
- B) The momentum operator

C) The absolute square of the wavefunction

- D) The time derivative of the wavefunction