SSR DEGREE & PG COLLEGE (AUTONOMOUS) NIZAMABAD
M.SC. PHYSICS
SEM – II INTERNAL – II
QUANTUM MECHANICS
QUESTION BANK

I. Multiple Choice

1.In a non-degenerate system, the unperturbed energy levels are:

A) Equal

B) Infinite

C) Distinct

D) Negative

Answer: C

2.Non-degenerate perturbation theory is applicable when:

A) Energy levels are distinct

B) All levels are degenerate

C) No perturbation exists

D) Energies are zero

Answer: A

3.Which correction involves the square of matrix elements?

A) Zeroth order

B) First order

C) Second order

D) All orders

Answer: C

4. If the perturbation is H'=\lambda x, the first-order correction to the ground-state energy is:

A) \lambda

B) \frac{\lambda}{2}

C) Zero

D) Infinite

Answer c

5. The wave functions of a harmonic oscillator are expressed in terms of:

A) Legendre polynomials

B) Bessel functions

C) Hermite polynomials

D) Laguerre polynomials

Answer: C

6.The major perturbation in the helium atom is due to:

A) Nuclear attraction

B) Electron spin

C) Electron-electron repulsion

D) Magnetic field

Answer: A

7.The linear Stark effect is observed prominently in:

A) Non-degenerate states only

B) Degenerate states only

C) Ground state of hydrogen only

D) Free electron gas

Answer: B

8.The Stark effect refers to the splitting of atomic energy levels due to the presence of:

A) Magnetic field

B) Electric field

C) Gravitational field

D) Pressure field

Answer: B

9. According to the variational principle, the expectation value of energy is:

A) Less than the true ground-state energy

B) Equal to zero

C) Greater than or equal to the true ground-state energy

D) Independent of trial function

Answer: C

10.The major difficulty in solving the helium atom exactly arises from:

A) Nuclear motion

B) Electron-electron repulsion

C) Spin-orbit coupling

D) Relativistic effects

Answer: B

11.Time-dependent perturbation theory is mainly used to study:

A) Atomic spectra only

B) Transition probabilities between states

C) Crystal structures

D) Thermodynamic processes

Answer: B

12.A sudden perturbation acts for:

A) Very long time

B) Infinite time

C) Very short time

D) No time

Answer: C

13. A transition occurs when an atom:

A) Absorbs or emits energy

B) Changes temperature

C) Changes pressure

D) Changes density

Answer: A

14. A forbidden transition generally has:

A) Higher probability

B) Lower probability

C) Infinite probability

D) Unit probability

Answer: B

15.Spectral line intensity depends mainly on:

A) Transition probability

B) Atomic mass

C) Density only

D) Pressure only

Answer: A

16. Fermi’s Golden Rule is used to calculate:

A) Ground-state energy

B) Transition rate between quantum states

C) Atomic radius

D) Electron spin

Answer: B

17.The transition probability per unit time is also called:

A) Transition amplitude

B) Transition rate

C) Density function

D) Wave function

Answer: B

18.If the density of final states increases, the transition rate:

A) Decreases

B) Remains constant

C) Increases

D) Becomes zero

Answer: C

19.Einstein introduced coefficients to explain:

A) Blackbody radiation

B) Radioactivity

C) Photoelectric effect only

D) Compton effect

Answer: A

20.Einstein's theory involves:

A) Two coefficients

B) Three coefficients

C) Four coefficients

D) Five coefficients

Answer: B

II. Fill in the blanks

1. 1. The WKB approximation is used to study quantum mechanical ____ through a potential barrier.

Answer: tunneling

2.In alpha decay, the alpha particle escapes from the nucleus by ____ through the Coulomb barrier.

Answer: tunneling

3.The probability of transmission through a potential barrier decreases ____ with increasing barrier width.

Answer: exponentially

4.The WKB method is valid when the potential varies ____ compared to the de Broglie wavelength of the particle.

Answer: slowly

5.The linear Stark effect is prominently observed in the ____ atom.

Answer: hydrogen

6.For the hydrogen atom, the n = 2 level is ____ fold degenerate (ignoring spin).

Answer: four

7.The external electric field removes the ____ of the unperturbed energy levels.

8.The quantum number of a harmonic oscillator takes values n = 0, 1, 2, \ldots, where n is a ____ integer.

Answer: non-negative

9.Perturbation theory is valid only when the perturbation does not significantly alter the ____ system.

Answer: original

10.The harmonic oscillator is one of the most important exactly solvable models in ____ mechanics.

Answer: quantum

11.Fermi's Golden Rule is named after the physicist ____.

Answer: Fermi

12.The rule is especially useful for transitions to ____ spaced energy levels.

Answer: closely

13.The probability of transition per unit time is proportional to the ____ of the perturbation matrix element.

Answer: square

14.The Einstein coefficients provide the theoretical basis for the operation of ____.

Answer: lasers

15.In thermal equilibrium, the rates of upward and downward transitions are ____.

Answer: equal

16.The process in which an atom absorbs radiation and moves to a higher energy level is called ____.

Answer: absorption

17.Degenerate perturbation theory is required when two or more states have the same ____.

Answer: energy

18.The second-order energy correction depends on the ____ elements of the perturbation Hamiltonian.

Answer: matrix

19.The perturbed wave function is expressed as a series in powers of the perturbation ____.

Answer: parameter

20.Harmonic perturbation is studied using ____-dependent perturbation theory.

Answer: time

III. Descriptive Question

1. Explain time independent perturbation theory for Non-degenerate system.

2.what an operator represents in quantum mechanics?

3.what is fermi's golden rule

4.using time dependent perturbation theory obtain expression for transition probability

5.write short note on linear stark effect

6.define constant perturbation