9/10/19

VCD SYBSc PHYSICS-IV (ATKT)SEM-IV 2019-20 100 MARKS 3HRS

Note: i) All the questions are compulsory.
ii) Figures to the right indicate full marks.
iii) Use of non programmable calculator is allowed.

Q.1.A]Select the correct option: [12M]

1)Hamiltonian operator is _____.
(a)momentum operator (b)kinetic energy operator
(c)potential energy operator (d)totalenergy operator

2)Energy levels of a bound system are _____
(a)discrete (b)continuous (c)discrete or continuous (d)discrete & continuous

3) Zero point energy is in conformity with _____.
(a)Planck's law (b) *Bohr's postulates*
(c) *Heisenberg's uncertainty principle* (d) None

4) Freezing of liquid helium at atmospheric pressure is explained by _____
(a)zero-point energy (b)tension-point energy
(c)infinite energy (d)undefined energy

5) The potential energy of a free particle is _____.
(a)positive (b)negative (c)zero (d)none

6)The energy levels of harmonic oscillators are _____ spaced.
(a)evenly (b)unevenly (c)randomly (d)none

Q.1.B] Answer in one statement: [3M]

1.Give one example of tunneling effect.
2.What do you mean by bound states of particle?
3.State 1D STIE.

Q.1.C] Fill in the blanks: [5M]

1)Quantum mechanics is _____ in nature.
2)The most fundamental equations of wave mechanics are called _____ equations.
3)Probability that the incident particle is reflected is called _____.
4)For higher values of "n", quantum behavior matches with the classical behavior.this is termed as _____.
5)In case of step potential if energy of particle is less than barrier potential then penetration depth _____ with increase in the mass of the particle.

Q.2.A] Attempt any one: - [8M]

a)Derive schrodinger's time independent equation.
b)What are operators? Write down the operators for momentum ,total energy, kinetic energy & angular momentum .

Q.2.B] Attempt any one: - [8M]

a)State the conditions of a 'well behaved' wave & show that $|\psi|^2 \neq |\psi 1|^2 + |\psi 2|^2$.
b)Starting from one dimensional simple harmonic progressive wave, derive classical wave equation.

Q.2.C] Attempt any one: - [4M]

a)If the normalized wave function of an oscillator is given by,$\psi = Ayexp(-y^2/2)$, $-\infty < y < \infty$. Find A
b)An eigen function of the operator d^2/dx^2 is $\psi = e^{2x}$.find the corresponding eigen value.

[8M]

Q.3.A] Attempt any one: -

a)Write the 1-D STDE for a free particle.Obtain its general solution & interpret it.

b)An α- particle having energy 10Mev approaches a potential step of height 50 Mev from left.Find the relative probability density of finding the particle just as it crosses to the right of the step at x =0 and also at x=10^{-15}m. Given:=1.054 x 10^{-34}Js, m_α = 6.68 x 10^{-27} kg

[8M]

Q.3.B] Attempt any one: -

a)What is meant by 1-D infinitely deep potential well? Obtain an expression for the allowed energy levels & the corresponding eigen functions for a particle of mass 'm' in such a potential.

b) A particle approaches a step potential of height V_o with energy E_o. Discuss quantum mechanical behavior of the motion of a particle when $E_0 > V_0$.

[4M]

Q.3.C] Attempt any one: -

a) Estimate the zero point energy for a neutron in a nucleus, by treating it as if it were in an infinite square well of width equal to a nuclear diameter of 10^{-14}m.
[Given :-m_n = 1.67 x 10^{-27}kg , h = 6.62 x 10^{-34}Js consider the problem to be one dimensional].

b) The energy of a particle in a 1-D box in the first excited state is 4eV.Calculate its ground state energy.

[8M]

Q.4.A] Attempt any one: -

a)With the help of a tunnel effect , explain the phenomenon of α-decay .Show that the decay constant depends on the transition probability.

b)For a potential well of finite height & width mark the 3 regions.Obtain the wave functions in these regions & explain tunnel effect.

[8M]

Q.4.B] Attempt any one: -

a) How can an α- particle actually escape from the nucleus.Calculate the zero point energy of a system consisting of mass of 1gm fixed to a spring which is stretched by 1 cm by a force of 10,000 dynes, the movement being constraint only along x-axis.

[4M]

Q.4.C] Attempt any one: -

a) For an electron beam of energy 3 eV incident on a potential barrier of height 4eV.Width of barrier is 20 A.U.Calculate the % transmission of the beam through the barrier.

b)Define simple harmonic oscillator & obtain expression for its potential energy & total energy.

[20M]

Q.5] Answer the following: -[Any four]

a)An eigen function of the operator d^2/dx^2 is $\psi = e^{2x}$.find the corresponding eigen value.

b)Normalize the following wave function. Ψ_n= sin $(n\pi x/l)$; $0 < x < l$ n is an integer.

c)Find the zero point energy in electron volt of a pendulum whose period is 1sec.

d)An electron with energy 20 eV encounters a potential step of height V_o.If the probability of reflection of the electron is 50%, find V_o.

e)Show that a particle in a box cannot have zero energy.Why is the ground state energy called the zero point energy?

f)For a free particle show that STIE leads to de-broglie relation $\lambda=\frac{h}{p}$.

-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-