UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

ONLINE END SEMESTER EXAMINATION
DECEMBER 2020

Course: QUANTUM MECHANICS AND APPLICATIONS **Semester: V**
Course Code: PHYS 3001
Programme: BSc (H): PHYSICS **Max. Marks: 100**
Instructions: Read the section headings carefully for Sections A, B and C **Total pages : 02**

SECTION A

1. Each Question will carry 5 Marks
2. Instruction: Complete the statement / Select the correct answer(s)

Q1	i.	As the wavelength of the radiation decreases from the maximum, the intensity of the black body radiations _____ a) Increases b) Decreases c) First increases then decrease d) First decreases then increase	CO1
	ii.	Suppose that when a scientist measured the electron, her readings had an uncertainty of $\Delta x = 1.0 \times 10^{-9}$ m. Given the mass of this particle is $3{:}5 \times 10^{-19}$ kg and $\hbar = 1.05 \times 10^{-34}$ m^2kg/s, the smallest uncertainty that she could possibly have in her measurement for the particle's velocity is -------- .	
Q2	i.	Light of wavelength 3500 Å is incident on two metals A and B. Which metal will yield more photoelectrons if their work functions are 5 eV and 2 eV respectively? a) A b) B c) A & B d) C	CO1
	ii.	Photons of energy 4.0×10^{-19} J cause transitions in an atom. The frequency and wavelength of such photons are ……. and ……... respectively. (Given $h = 6.626 \times 10^{-34}$ Js).	
Q3	i.	The radiations emitted by hot bodies are called as _____ a) X-rays b) Black-body radiation c) Gamma radiations d) Visible light	CO1
	ii.	The concept of matter wave was suggested by_____ a) Heisenberg b) de Broglie c) Schrodinger d) Laplace	
	iii.	The function representing matter waves must be _____ a) complex b) real c) zero d) infinity	
Q4	i.	The Schrodinger wave equation is _____ a) Linear b) Quadratic c) Differential equation d) Derivable	CO1
	ii.	Two operators, α and β, are said to commute when _____ a) $\alpha = \beta$ b) $\alpha + \beta = 0$ c) $\alpha\beta = \beta\alpha$ d) $\alpha^2 = \beta^2$	

	iii. What is Compton shift? a) Shift in intensity b) Shift in charges c) Shift in radiation d) Shift in wavelength	
Q5	i. An operator representing observable dynamical variable has _____ value. a) always b) infinite c) real d) imaginary	CO2
	ii. Position operator in a momentum space is given by r_{op} = _____ (a) $i\hbar\nabla p$ (b) $i\hbar r_{op}$ (c) $i\frac{\partial}{\partial x} + j\frac{\partial}{\partial y} + k\frac{\partial}{\partial z}$ (d) $(2m/\hbar^2)\nabla$	
Q6	i. If there exist only one eigen function corresponding to a given eigen value, then the eigen value is called _....._____ a) Non degenerate b) degenerate c) discrete d) continuum	CO2
	ii. If the particle moving in a _____ potential then the solutions of the wave equation are describe as a stationary states a) time independent b) time dependent c) velocity dependent d) velocity independent	
	iii. If there exist more than one eigen function corresponding to a given eigen value, then the eigen value is called _____ a) Non degenerate b) degenerate c) discrete d) continuum	

SECTION B

1. Each question will carry 10 marks

2. Instruction: Write short / brief notes

Q7	Consider the SHO (Simple Harmonic Oscillator) problem in quantum physics. Compare its results with those obtained in classical physics.	CO3
Q8	Describe the famous Stern-Gerlach experiment. Expound the significance of its results.	CO4
Q9	Explain the concept of indistinguishability of particles in Quantum Mechanics. Apply the concept to understand Symmetric and Antisymmetric wave functions.	CO4
Q10	What are Spin orbit couplings? What are they used for?	CO4
Q11	Write short note on Momentum space and momentum wave functions.	CO2

Section C

1. Each Question carries 20 Marks.

2. Instruction: Write long answer.

Q12	Give the Quantum theory of Hydrogen atom. [Hint: Write down the Schrodinger equation for hydrogen atom, and using appropriate physical conditions solve it. Give out the quantum numbers involved and interpret the solutions in your own language. ☺] OR a. What are associated Laguerre, zenithal and azimuthal angular equations for the hydrogen atom? Describe their solutions in detail. b. Give the complete set of quantum numbers for an atom. Describe each quantum number and the values it can take.	CO3