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6188

Reg. No. :

Name :

Fifth Semester B.Sc. Degree Examination, November 2013 First Degree Programme under CBCSS PHYSICS Core Course - VI PY 1542 : Quantum Mechanics

Time: 3 Hours

Weight: 30

SECTION - A

This Section contains four bunches each of four questions. Answer all questions, Each bunch carries a weightage of one.

I. Choose the correct answer.

- 1) The laws of photoelectric emission
 - a) are explained by Maxwell's theory of light
 - b) state that emission is inversely proportional to the intensity of the incident light
 - c) state that increasing the intensity of the incident light increases the kinetic energy of the photoelectrons
 - d) state that increasing the frequency of the incident light increases the kinetic energy of the photoelectrons

2) In Schrödinger wave equation, the symbol ψ represents the

- a) wavelength of the spherical wave
- b) amplitude of the spherical wave
- c) frequency of the spherical wave
- d) none of these
- 3) An electron and proton have same de Broglie wavelength. They will have equal

a) velocity b) energy c) momentum d) size

- 4) Which of the following wave functions represent a free particle moving along +X axis?
 - a) A sin(kx ωt)

b) A cos(kx + ω t)

c) $Ae^{i(kx - \omega t)}$

d) Ae^{-i(kx - ωt)}

P.T.O.

- II. Name the following :
 - 5) Who introduced the concept of privileged orbits ?
 - 6) A potential which is zero everywhere, except at a single point, where it takes an infinite value.
 - 7) Name a unitary space that is complete.
 - 8) $\pi \psi(x) = \psi(-x)$. Name the operator π .
- III. Fill in the blanks with most appropriate word or numerical value.
 - 9) Rutherford investigated nuclear structure by bombarding gold foil with ____
 - 10) When the operators A and B commute each other [A, B] $\psi = _$
 - 11) Different quantum states having same eigen value for an operator are called
 - 12) Quantum mechanics, in its most general formulation, is a theory of operators (observables) acting on an abstract space called _____
- IV. State whether the following statements are true or false.
 - 13) To emit light an atom must be ionized.
 - 14) Statistical interpretation of wave function was given by Schrodinger.
 - 15) For dispersive medium phase velocity can be greater than group velocity.
 - 16) The de Broglie wavelength (λ) , of a particle of charge q accelerated through a potential difference of V volt, increases with V.

SECTION - B

Answer any eight questions. Each question carries a weightage of one.

- 17) State two experimental features of blackbody emission spectra.
- 18) Why "quantum physics" is named as it is ? What necessitated the evolution of this branch of physics ?
- 19) Explain wave particle duality.
- 20) What does it mean to say that certain operators commute ?

- 21) What are the criterions to call a vector space linear?
- 22) Show that $[x, p_x] = i\hbar$.
- 23) What does the square of the wave function signify ? What is the difference ψ and $|\psi^2|$?
- 24) Write note on scattering matrix.
- 25) State and explain Ehrenfest's theorem.
- 26) What do you mean by the expectation value of an operator?
- 27) Express linear momentum of a photon in terms of wave vector k and energy of photon in terms of angular momentum ω.
- 28) What is zero point energy ? Also show quantitatively that the energy of a harmonic oscillator is quantised.

SECTION-C

Answer any five questions. Each question carries a weightage of two.

- 29) Show that the de Broglie wavelength of an electron, of energy V eV, moving with a very small velocity compared to that of light is 12.3 $V^{-\frac{1}{2}}$.
- 30) The work function of a metal is 3.45 eV. Find what should be the maximum wavelength of a photon that can eject photoelectron from the metal.
- 31) An electron has a speed of 300 m/s accurate to 0.01%. With what fundamental accuracy can we locate the position of the electron ?
- 32) Derive the relation between group velocity and phase velocity.
- 33) Show that the eigen functions of a Hermitian operator are othogonal if they correspond to different eigen values.
- 34) Normalise the wave function $\psi(x) = A \sin(\pi x / a)$ for 0 < x < a and $\psi(x) = 0$ outside.
- 35) Obtain the expressions linear momentum operator and energy operator.
- 36) Show that the operator $\frac{\partial}{\partial x}$ and $\frac{\partial}{\partial t}$ commute each other.

SECTION - D

Answer **any two** questions from **3**. **Each** question carries a weightage of four.

- 37) State and prove uncertainty principle. Using the principle show that electrons can not exist inside the nucleus.
- 38) Derive time dependent Schrodinger equation. What do you mean by saying that the Schrodinger equation is time dependent and time independent?
- 39) Solve the schrodinger equation for the motion of a free particle in an infinite square well potential.