D 50730

(Pages:4)

Name.....

Reg. No.....

Maximum : 30 Weightage

FIFTH SEMESTER B.Sc. DEGREE EXAMINATION, NOVEMBER 2013

(UG-CCSS)

Physics—Core Course

PH 5B 10 / AP 5B 12-QUANTUM MECHANICS

(Common for Applied Physics)

Time : Three Hours

Section A

Answer all questions.

1. Matter waves

- (a) Are longitudinal.
- (b) Are electromagnetic.
- (c) Always travel with speed of light. (d) Show diffraction.

2. According to Schrödinger, a particle is equivalent to a :

- (a) Single wave. (b) Wave-packet.
- (c) Light wave. (d) Cannot behave as wave.

3. The uncertainty relation cannot hold for the following pairs :

- (a) Position and momentum. (b) Energy and time.
- (c) Linear momentum and angle. (d) Angular momentum and angle.
- 4. A particle possesses discrete energy levels :
 - (a) In free space. (b) In a box of rigid walls.
 - (c) Both (a) and (b). (d) Neither (a) nor (b).
- 5. The allowed energy valves of a particle in box of length L are given by :

(a)
$$\frac{n^2 \pi^2 \hbar^2}{mL^2}.$$

(c)
$$\frac{\pi^{-} h^{-}}{2mL^{2}n^{2}}$$

6. The energy operator is :

 $\frac{n}{i}\nabla$.

(c)

- (a) $\frac{h}{i}\frac{\partial}{\partial t}$.
- (d) $i\hbar\nabla$.

(b) $i\hbar\frac{\partial}{\partial t}$.

(b) $\frac{n^2 \pi^2 \hbar^2}{2m \Gamma^2}$.

nπh 2mL

(d)

Turn over

D 50730 2 The potential function of harmonic oscillator is : 7. (b) Parabolic. (a) Linear. (c) Elliptical. (d) Hyperbolic. 8. When a particle of energy $E < V_0$ is incident on a potential barrier of height V_0 , then the probability of penetration is : (b) 1. (a) Zero. (d) Infinite. (c) Finite. 9. The energy levels of harmonic oscillator according to Schrödinger's equation is : (b) $\left(n+\frac{1}{2}\right)\hbar w.$ (a) nħw. (c) $\frac{n\omega}{\left(n+\frac{1}{2}\right)}$. (d) $\left(n^2-1\right)\hbar w$. 10. Of the following having the same kinetic energy, which has the longest wavelength : (b) Proton. An electron. (a) (d) α -particle. (c) Neutron. 11. For orthogonal wave functions, the value of $\int \psi_m^* \psi_n dx$ is : (b) 0. (a) 1. (d) - 1.(c) 00. 12. The waves associated with electrons are called : (b) Sound waves. (a) Light waves: Transverse waves. (d) (c) Matter waves. $(12 \times \frac{1}{4} = 3 \text{ weightage})$ Section B Answer all questions.

13. State the principle of superposition of waves.

14. State the postulates of quantum mechanics.

15. Explain uncertainty principle.

- 16. What is electron spin hypothesis.
- 17. What do you mean by tunnelling through a barrier?
- 18. Explain the significance of wave function.
- 19. What is correspondence principle?
- 20. Distinguish between phase velocity and group velocity.
- 21. Write Schrödinger's time dependent wave equation.

 $(9 \times 1 = 9 \text{ weightage})$

Section C

Answer any five questions.

- 22. Find the change in wavelength of an X-ray photon when it is scattered through an angle of 90° by a free electron.
- 23. What voltage must be applied to an electron microscope to produce electrons of wavelength 1A°.
- 24. Find the normalisation constant of a particle constrained to move in an one dimensional infinite

potential well of width L, such that $0 \le x \le L$, whose wave function is $\Psi_x = A \sin\left(\frac{n\pi x}{L}\right)$, where n is an integer.

- 25. Calculate the total energy of the electron in the first Bohr orbit, in electron Volt. (Given electron rest mass $m = 9.11 \times 10^{-31}$ kg, electron charge $e = 1.6 \times 10^{-19}$ C, Planck's constant $h = 6.63 \times 10^{-34}$ Js), permittivity of free space $\epsilon_0 = 8.85 \times 10^{-12}$ C²/Nm² and 1eV = 1.6×10^{-19} J)
- 26. 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 ?
- 27. Calculate the value of Bohr radius.
- 28. Calculate the de Broglie wavelength of neutrons of Kinetic energy 1eV.

 $(5 \times 2 = 10 \text{ weightage})$

Section D

Answer any two questions.

- 29. What is a wave function ? Derive Schrödinger's time Independent equation.
- 30. Describe Davisson and Gemer experiment for the study of diffraction of electrons and show that the results of this experiment are closely in agreement with de-Broglie wavelength of electrons.

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 - 31. (a) Write the time- independent Schrödinger wave equation for the hydrogen atom in spherical polar co-ordinates and separate it into three differential equations for the three parts of the total wave-function.
 - (b) Solve the azimuthal wave function and show that the magnetic quantum number m_r must be zero or a positive or negative integer. (2 × 4 = 8 weightage)

Bection C

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- 22. Find the change in wavelength of an X-ray photon when it is scattered ittrough an angle of 30° by a free electron.
- 23. What voltain must be applied to in electron microscope to produce electrons of wiredeaptin 1A*.
- 24 Find the pormalisation constant of a particle constrained to move in an one dimensional infaits.

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- 26. An electrica has a speed of 300 mile modifieds to 0.01 %. With what fundamental Senaracy can we break the position of the electron ?
 - 27. Calculus the value of Bohr runnia.
 - S Celeulate the de Broglie wavelength of neutrons of Unetic energy JeV.

(in x 2 = 10 wing many)

Section D.

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- 30 Describe Davisson and Geness systeriment for the study of sliftigation ideals brain and show that the results of this experiment inte cloudy in agreement with de-Broghe wavelength of electrons.

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