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Name.....

Reg. No.....

**FIFTH SEMESTER B.Sc. DEGREE EXAMINATION, NOVEMBER 2016**

(CUCBCSS-UG)

Physics/Applied Physics

PHY 5B 07/APY 5B 08—QUANTUM MECHANICS

Time : Three Hours

Maximum : 80 Marks

*The symbols used in this question paper have their usual meanings.*

**Section A**

*Answer all questions in a word or a phrase.*

*Each question carries 1 mark.*

1. In photoelectric effect, for a particular frequency, the number of photoelectrons emitted is proportional to \_\_\_\_\_ of the radiation.
  2. What is the relation between particle momentum and the wave number of the de Broglie wave associated with it ?
  3. Which spectral series of hydrogen falls in the visible region of the electromagnetic spectrum ?
  4. What are the eigen functions of a quantum harmonic oscillator ?
  5. What is the magnitude of angular momentum due to spin of an electron ?
- Write True or False :
6. Davissons and Genner experiment confirms wave nature of electrons.
  7. In most of the practical situations, group velocity is higher than the particle velocity.
  8. Due to nuclear motion, all energy levels of hydrogen are increased by a very small fraction.
  9. The wave function is a measurable quantity.
  10. An electron in an orbit does not radiate energy.

(10 × 1 = 10 marks)

**Section B**

*Answer all questions in two or three sentences.*

*Each question carries 2 marks.*

11. Draw the spectrum of a blackbody and indicate the regions obeying Raleigh-Jeans law and Wien's law.
12. Write down the Einstein photoelectric equation. What are the terms involved ?
13. What are de Broglie waves ? Give an expression for the de Broglie wavelength.
14. What is the basic working principle of an electron microscope ?

Turn over

15. What do you mean by the Bohr radius of a hydrogen atom? Write down the expression for radius of orbits in terms of the Bohr radius.
16. What do you mean by the term zero point energy of a quantum harmonic oscillator? What is value?
17. Illustrate the Pauli's exclusion principle. (7 × 2 = 14 marks)

### Section C

*Answer any five questions in a paragraph of about half a page to one page.*

*Each question carries 4 marks.*

18. Explain the pair production phenomenon. Does it violate any conservation law? Is it possible pair production to occur in free space?
19. What is gravitational red shift? Obtain an expression for the relative frequency change.
20. Discuss the energy-time uncertainty principle. Does uncertainty exists in classical mechanics?
21. What are the purpose of Franck-Hertz experiment? Draw the schematic of Franck-Hertz experiment setup and indicate the parts.
22. Using suitable figures, explain the origin of emission and absorption lines of atoms.
23. Discuss the essential conditions on a wavefunction.
24. Explain the normal Zeeman effect.

(5 × 4 = 20 marks)

### Section D

*Answer any four questions.*

*Each question carries 4 marks.*

*Problems write all relevant formulas, all important steps carry separate marks.*

25. Light of wavelengths 3125 Å and 3650 Å causes the emission of electrons having kinetic energy 2.128 eV and 1.595 eV respectively from sodium. Determine the value of Planck's constant from this data.
26. Estimate the de Broglie wavelength of an electron which is accelerated through a potential difference of 100 V.
27. The average period that elapses between the excitation of an atom and the time it emits radiation is  $10^{-8}$  s. Determine the width of the excited state.
28. Determine the wavelength of the photon required to ionize a hydrogen atom in the ground state and gives the ejected electron a kinetic energy of 10.5 eV.
29. Find the expectation value of the momentum of a particle enclosed in a one-dimensional box.
30. Electron with energy 1 eV is incidence on a barrier of height 10 eV and width 0.5 nm. Find the transmission probability.
31. Compare the angular momentum of a ground state electron in the Bohr model of the hydrogen atom with its value in the quantum theory.

(4 × 4 = 16 marks)

**Section E (Essays)**

*Answer any two questions in about two pages.*

*Each question carries 10 marks.*

32. What is the importance of Compton effect ? Obtain an expression for the change in wavelength of a Compton scattered photon.
33. What are the essential features of Bohr atom model ? Discuss the origin of the spectral series of hydrogen.
34. Discuss qualitatively the tunnel effect observed in case of a particle approaching a potential barrier of finite width, with kinetic energy less than the barrier height.
35. Explain the quantum numbers associated with hydrogen atom. What are their values ? Explain the significance of the quantum numbers.

(2 × 10 = 20 marks)