D 10244 (Pages : 3) Name...

Reg. No....................................

FIFTH SEMESTER U.G. DEGREE EXAMINATION, NOVEMBER 2021

(CUCBCSS—UG)

Physics/Applied Physics

PHY 5B 07/APY 5B 08—QUANTUM MECHANICS

Time : Three Hours Maximum : 80 Marks

Section A

*Answer **all** questions in a word **or** phrase.*
Each question carries 1 mark.

1. Einstein's photoelectric equation is —————.

2. Write down the energy eigen value of particle in a one dimensional box.

3. Write down the uncertainty relation between energy and time.

4. Write down the selection rules for allowed transitions in a hydrogen atom.

5. Write down the one dimensional time dependent Schrodinger equation.

 Write true *or* false :

6. Although they lack rest mass, photons behave as though they have gravitational mass.

7. A group of waves need have the same velocity as the waves themselves.

8. An electron can circle a nucleus only if its orbit contains an integral number of de Broglie wavelengths.

9. For a harmonic oscillator the lowest energy will be E = 0.

10. The quantization of electron energy in the hydrogen atom is described by the principal quantum number.

(10 × 1 = 10 marks)

Section B (Short Answer Type)

*Answer **all** questions in two **or** three sentences.*
Each question carries 2 marks.

11. Define group velocity.

12. State the postulates of Bohr atom model.

13. Write down the eigen value equation and define eigen value and eigen function.

Turn over

14. What are Hermition operators ? Write one example.

15. Write down the validity conditions of wave functions.

16. State Exclusion principle.

17. Bring out the conclusion of Stern Gerlach experiment.

$(7 \times 2 = 14 \text{ marks})$

Section C (Paragraph Type)

Answer any **five** *questions in a paragraph of about* **half a page to one page.**
Each question carries 4 *marks.*

18. Write a short note on Compton effect.

19. Discuss the principle and working of electron microscope.

20. Discuss Correspondence principle.

21. Write a short note on tunnel effect.

22. Write a note on scanning tunneling microscope.

23. Briefly discuss Zeeman effect.

24. What are the quantum numbers used in hydrogen atom ? Explain.

$(5 \times 4 = 20 \text{ marks})$

Section D (Problems)

Answer any **four** *questions.*
Each question carries 4 *marks.*

25. The threshold frequency of a certain metal is 3.3×10^{14} Hz. If light of frequency 8.2×10^{14} Hz is incident on the metal, then find the cut off voltage for photo electric emission.

26. An electron has a speed of 500m/s with an accuracy of 0.004%. Calculate the certainty with which we can locate the position of the electron.

27. A Positronium atom is a system that consists of a positron and an electron that orbit each other. Compare the wavelengths of the spectral lines of positronium with those of ordinary hydrogen.

28. Find the shortest and longest wavelength in the Balmer series.

29. Prove that commuting operators have common set of eigen functions.

30. A particle limited to the x-axis has the wave function $\psi = ax$ between $x = 0$ and $x = 1$; $\psi = 0$ elsewhere : (a) find the probability that the particle can be found between $x = 0.45$ and $x = 0.55$; (b) find the expectation value of the position of the particle.

31. A sample of a certain element is placed in a 0.300T magnetic field and suitably excited. How far apart are the Zeeman components of the 450nm spectral line of this element ?

$(4 \times 4 = 16 \text{ marks})$

Section E (Essays)

Answer any **two** *questions in about* **two pages.**
Each question carries 10 *marks.*

32. Explain ultraviolet catastrophe. With reference to Planck's formula explain how Max Planck solve this discrepancy.

33. What do you mean by de Broglie waves ? Explain the experiment that confirms the existence of de Broglie waves.

34. Explain the different postulates of quantum mechanics in detail.

35. Write the Schrodinger equation for hydrogen atom and obtain the expression for Φ, Θ and R using separation of Variables.

$(2 \times 10 = 20 \text{ marks})$