18U507 (Pages: 3) Name: ……..……..

Reg. No…….

FIFTH SEMESTER B.Sc. DEGREE EXAMINATION, NOVEMBER 2020

(CUCBCSS-UG)

(Regular/Supplementary/Improvement)

CC15U PH5 B07 - QUANTUM MECHANICS

(Physics - Core Course)

(2015 Admission onwards)

Time: Three Hours Maximum: 80 Marks

The symbols used in this question paper have their usual meaning.

Section A

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

1. The de Broglie wavelength of an electron accelerated to a potential difference of V volts is …….
2. If $\psi(x) = Ae^{-x}$ for $0 < x < \infty$, the normalization constant is …….
3. If the frequency of light in a photoelectric experiment is doubled, the stopping potential will …….
4. In Compton scattering the incident photon losses maximum energy to the electron when the photon is scattered at …….
5. The z- component of spin magnetic moment is equal to …….

Write true or false:

6. Davisson and Germer experiment confirms particle behaviour of electron.
7. Two photons having equal energies have equal linear momenta.
8. According to Bohr atom model, the orbital radius of electron is directly proportional to n.
9. The potential function of harmonic oscillator is linear.
10. Fine structure in spectral lines and anomalous Zeeman effect, are explained on the basis of electron charge.

(10 x 1 = 10 Marks)

Section B

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

11. Why Compton effect cannot occur with visible light?
12. Explain energy-time uncertainty principle. Does uncertainty exists in classical mechanics?
13. What is the importance of Frank-Hertz experiment?

14. What is meant by expectation value?
15. What is meant by normalised and orthogonal wave functions?
16. Define Bohr magneton. Write down an expression for it.
17. What is meant by space quantization of spin angular momentum?

(7 x 2 = 14 Marks)

Section C

Answer any ***five*** questions in a paragraph. Each question carries 4 marks

18. Show that it is impossible for pair production to conserve both energy and momentum unless some other object is involved in the process to vary away part of photon.
19. What is the basic working principle of an electron microscope?
20. Write down expressions for energy level with and without taking nuclear motion into account. Elaborate on both.
21. Why the energy of a particle trapped in a box is quantized?
22. What is meant by radiative transition?
23. What are the similarities and dissimilarities of the predictions of classical and quantum oscillators?
24. Show that for a non-relativistic free particle, the phase velocity is half the group velocity.

(5 x 4 = 20 Marks)

Section D

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

Problems write all relevant formulas, all important steps carries separate marks.

25. The suns mass is 2 X 10^{30} kg and its radius is 7 X 10^{8} m. Find the approximate gravitational red shift in light of wavelength 500 nm emitted by the sun.
26. An electron has a speed of 300m/s accurate to 0.01%. With what fundamental accuracy can we locate the position of the electron.
27. Find the shortest wavelength present in the radiation from an X-Ray machine whose accelerating potential is 50,000V.
28. Light of wavelength 4500Å ejects photoelectrons from a sodium surface of work function 2.3eV. The stopping potential is experimentally found to be 0.46 volts. Calculate Planck's constant.
29. Find the wavelength of the spectral line that corresponds to a transition in hydrogen from the n = 10 state to the ground state. In what part of the spectrum is this?

30. A sample of a certain element is placed in a magnetic field of strength 0.4T and suitably excited. How to apart are the Zeeman components of 400nm spectral line of this element.
31. Electron with energy 1eV is incidence on a barrier of height 10eV and width 0.5nm. Find the transmission probability.

(4 x 4 = 16 Marks)

Section E (Essays)

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

32. What is black body radiation? Discuss the Rayleigh Jeans formula and Planck radiation formula in explaining the black body spectra. Bring out the salient differences.
33. Elaborate on matter waves and its significance. Explain how particle diffraction was used as an experimental tool for verifying De Brogliés hypothesis.
34. What is a stationary state? Derive steady state form of Schrödinger equation from time dependent form.
35. Applying the separation of variable method, obtain the differential equation of hydrogen atom.

(2 x 10 = 20 Marks)

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