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(FOR THE CANDIDATES ADMITTED DURING THE ACADEMIC YEAR 2021-2024 ONLY)

SUBJECT CODE 21UPS509

REG.NO. :

N.G.M.COLLEGE (AUTONOMOUS) : POLLACHI

END-OF-SEMESTER EXAMINATIONS :NOVEMBER - 2023

B.Sc., PHYSICS **MAXIMUM MARKS: 70**

V SEMESTER **TIME : 3 HOURS**

PART - III

RELATIVITY & QUANTUM MECHANICS

SECTION - A (10 X 1 = 10 MARKS)

ANSWER THE FOLLOWING QUESTIONS.

MULTIPLE CHOICE QUESTIONS. (K1)

1. Which phenomenon demonstrated that electrons can only occupy discrete energy levels in aatom?

   a). Photoelectric effect b). Compton scattering

   c). Blackbody radiation d). Atomic emission spectra

2. What is the fundamental equation that describes the behavior of quantum mechanical systems?

   a). Newton's Second Law b). Maxwell's Equations

   c). Schrödinger Equation d). Einstein's Mass-Energy Equivalence Equation

3. What is the potential energy function inside an infinite square well potential?

   a).V = 0 for $0 < x < L$ b). $V = \infty$ for $0 < x < L$

   c). V = 1 for $0 < x < L$ d). V(x) = 0 for all L

4. What is the maximum number of electrons that can occupy an orbital with principal quantum number (n) = 3?

   a). 2 b.) 6 c). 8 d). 18

5. Which of the following phenomena is a consequence of time dilation in Special Relativity?

   a). Length Contraction b). Twin Paradox c). Mass Increase d). Time Reversal

ANSWER THE FOLLOWING IN ONE (OR) TWO SENTENCES. (K2)

6. Why does classical mechanics fail to account for the heat capacity of solids at low temperatures?
7. Define the normalization of a wave function?
8. Give the expression for the one-dimensional harmonic oscillator's energy eigenvalues?
9. What does the principal quantum number (n) indicate in an atom?
10. List the postulates of special relativity according to Einstein?

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SECTION – B (5 X 4 = 20 MARKS)

ANSWER EITHER (a) OR (b) IN EACH OF THE FOLLOWING QUESTIONS. (K3)

11. a). Explain the inadequacy of classical mechanics in explaining black body radiation.

(OR)

b). Discuss briefly the wave nature of matter and obtain an expression of de Broglie wavelength for matter waves.

12. a). Give an account of Heisenberg's uncertainty Principle. Outline an idealized experiment to bring out its significance.

(OR)

b). Explain the properties of the wave function in detail.

13. a). Determine the energy of a linear harmonic oscillator and the harmonic oscillator wave functions.

(OR)

b). Analyze the Infinite square well potential problem of a free particle.

14. a). Explain the significance of the radial equation in quantum mechanics.

(OR)

b). Explain the origin and significance of various quantum numbers n, l and m_l.

15. a). Describe the Michelson-Morley experiment and explain the physical significance of negative results obtained.

(OR)

b) State and explain the basic postulates of Einstein's special theory of relativity. Derive the Lorentz space-time transformation formulae.

SECTION – C (4 X 10 = 40 MARKS)

ANSWER ANY FOUR OUT OF SIX QUESTIONS

(16^{th}QUESTION IS COMPULSORY AND ANSWER ANY THREE QUESTIONS (FROM Qn. No : 17 to 21) (K4 (Or) K5)

16. Obtain the volume of a cube, the proper length of each edge of which is l_0, when it is moving with a velocity 'v' along one of its edges.
17. Describe briefly the experiment of G.P. Thomson on the diffraction of electrons. Explain briefly the results obtained.
18. What are the postulates of wave mechanics? Derive the Time-dependent form of Schrodinger's equation.
19. Provide the mathematical formulation of the particle encountering a one-dimensional potential barrierproblem.
20. Solve the Schrodinger's equation for the case of the hydrogen atom.
21. Deduce the formula for relativistic variation of mass with velocity. Briefly explain its significance.