# Avinashilingam Institute for Home Science and Higher Education for Women

**(Deemed to be University under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956)**
**Re-accredited with 'A+' Grade by NAAC. Recognised by UGC Under Section 12B**
**Coimbatore - 641 043, Tamil Nadu, India**

**Bachelor's Degree Examination – August 2020**
**VI Semester**

**Class : III UG** **Time : 2 Hours**
**Major : Physics** **Max. Marks : 50**

## 15BPHC23 Quantum Mechanics and Relativity

**Part A** **10 x 1 = 10**
**Choose the Correct Answer**

1. The wavelength of matter waves increases with
   a. increase in momentum b. increase in mass
   c. increase in velocity d. decrease in momentum

2. The concept of electron waves was proved by
   a. De Broglie b. Davisson and Germer
   c. Schrodinger d. Laplace

3. The function representing the matter waves must be
   a. real b. complex
   c. infinity d. zero

4. The normalized wave function must have _____ value.
   a. Infinite b. Zero
   c. Finite d. Negative

5. For particle in a box _____ at the boundary (on the walls).
   a. potential energy goes to infinity b. potential energy goes to zero
   c. kinetic energy goes to infinity d. both a and c

6. The potential energy of electron in hydrogen atom is given by
   a. $V(r) = -(e^2/r)$ b. $V(r) = -(m^2/r)$
   c. $V(r) = -(r^2/e)$ d. $V(r) = 0$

7. Find the false statement about special theory of relativity
   a. an assumption of special relativity is that the laws of physics are the same in all reference frames.
   b. an assumption of special relativity is that the speed of light is the same in all reference frames.
   c. special relativity says that space and time are part of the same thing: spacetime.
   d. an assumption of special relativity is that the laws of the physics are the same in all 'constant velocity' reference frames.

8. Which of the following expressions gives the relativitic kinetic energy of an object?
   a. $KE = (1/2)\, mv^2$ b. $KE=mc^2$
   c. $KE = \gamma mc^2$ d. $KE = (\gamma - 1)mc^2$

9. As an object approaches the speed of light, it's mass becomes
   a. zero b. double
   c. remains same d. infinite

10. According to Einstein's Special Theory of Relativity, laws of physics can be formulated based on
    a. inertial frame of reference b. non-inertial frame of reference
    c. both inertial and non-inertial frame of reference d. quantum state

## Part B 3 x 6 = 18

Answer any **Three** questions

**Each answer should not exceed 400 words or two pages**

11. State and explain de Broglie equation of matter waves.

12. Write a note on properties of matter waves and give the difference between group velocity and phase velocity.

13. Define wave function and write a note on probability density.

14. Write the postulates of Quantum Mechanics.

15. A particle in an infinite potential well can have zero energy. Comment on the statement and justify.

16. Write the significance of Eigen function and Eigen Value ($E_n$) for a particle in a box.

17. Classify inertial and non-inertial frame of references.

18. Write a note on length contraction.

19. Mass- Energy equivalence can be applied to a fast moving vehicle on road which travels at 100 Km/hr. State true or false and Justify.

20. Write a short note on important findings in General theory of relativity.

## Part C 2 x 11 = 22

Answer any **Two** questions

**Each answer should not exceed 800 words or four pages**

21. Explain the concept of matter waves using G.P.Thomson's experiment with a neat diagram.

22. Interpret the results of Davission and Germer Experiment in demonstrating the presence of matter waves.

23. Derive the time dependent Schrödinger wave equation.

24. Describe normalised and orthogonal wave functions.

25. Using the Schrödinger equation find the Eigen function and Eigen value for a particle in a box.

26. Find the Eigen value of the one dimensional linear harmonic oscillator by obtaining and solving its wave equation.

27. With a neat diagram describe the Michelson-Morley experiment and write the important findings of Michelson-Morley experiment.

28. Describe the set of Lorentz transformation equations in relativity.

29. Describe the gravitational red shift and write a note on black holes.

30. Derive the Einsteins mass-energy equation.

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