SUBJECT CODE : 15PH/MC/QR64

B.Sc. DEGREE EXAMINATION APRIL 2018
BRANCH III - PHYSICS
SIXTH SEMESTER

COURSE : **MAJOR – CORE**
PAPER   : **QUANTUM MECHANICS AND RELATIVITY**
TIME   : **3 HOURS.**   **MAX. MARKS : 100**

SECTION – A

ANSWER ALL QUESTIONS: **(30 x 1 = 30)**
I   Choose the Correct Answer:

1. The de Broglie wavelength of a particle of charge e accelerated to a potential difference V is proportional to
    a. V   b. 1/V   c. $\sqrt{V}$ d. $1/\sqrt{V}$

2. For a dispersive medium
    a. $v_p = v_g$ b. $v_p > v_g$ c. $v_p < v_g$ d. $v_p = 1$

3. The de Broglie wavelength of an electron travelling at one tenth the speed of light
    a. 0.024 nm   b. 0.024 A.U   c. 2.4 nm   d. 2.4 A.U

4. The energy of a particle in a square well of length L is proportional to
    a. L^2 b. $1/L^2$ c. $\sqrt{L}$ d. $1/\sqrt{L}$

5. For a normalized wave function $\int |\psi|^2 d\tau =$
    a. 0   b. 1   c. -1   d. ∞

6. The minimum energy of an electron in a box of width 1 A^0 is
    a. 13. 6 eV   b. 0 eV   c. 38 eV   d. 38 J

7. The eigen value of parity operator P is
    a. 0   b. 1   c. -1   d. $\pm$ 1

8. [P, H] =
    a. 0   b. 1   c. -1   d. $\pm$ 1

9. [L^2, Lz] =
    a. 0   b. 1   c. -1   d. $\pm$ 1

10. In Newtonian mechanics, the mass of a body does not depend on………….of its motion.
    a. position   b. time   c. displacement   d. velocity

11. Accelerated frames are called
    a. inertial   b. non inertial   c. static   d. dynamic

12. Explanation for negative result of Michelson Morley experiment was given by
    a. Einstein   b. Newton   c. Lorentz   d. Galileo

13. A rod of 1m length moving a 0.6 c appears to be at what length for an observer in earth?
    a. 1m   b. 1.1 m   c. 0.8 m   d. 1.2 m

14. The clock in an moving rocket will appear to go slower than the clock on earth's surface by a factor
    a. $\sqrt{(1 - v^2/c^2)}$ b. $(1 - v^2/c^2)$ c. $\sqrt{(1 - c^2/v^2)}$ d. $(1 - c^2/v^2)$

15. At what speed is a particle moving if its mass is twice its rest mass?
    a. 0.75 c   b. $\sqrt{0.75}c$ c. 0.25 c   d. $\sqrt{0.25}c$

...2

II Fill in the blanks:

16. The de Broglie wave velocity $v_p =$_____
17. The quantum mechanical momentum operator $p_x =$ _____
18. $[L_-, L_-]=$_____
19. Michelson Morley experiment suggests that there is no _____motion between earth and ether.
20. An object which appears spherical to an observer at rest relative to it, will appear _____ for a moving observer.

III State whether true or false:

21. The Bohr complementary principle states that particle and wave aspects of a physical entity are complementary and can be exhibited at same time.
22. The expectation value $<x>$ of the position of a particle trapped in a box L wide is L/2.
23. Parity operator is a Hermitian operator.
24. Laws of Physics are same in all non inertial frames of reference.
25. The rest energy of an electron is 0.51 MeV.

IV Answer briefly:

26. State Superposition Principle.
27. Give Schroedinger's time independent equation.
28. Give the commutation relation between Hamiltonian H and momentum p.
29. Show that for $v<< c$, Lorentz transformation reduces to Galilean transformation.
30. Give the relativistic formula for kinetic energy.

SECTION – B (5 X 5 = 25)
ANSWER ANY FIVE QUESTIONS :

31. What is the kinetic energy of a proton whose de Broglie wavelength is 1 fm.
32. Calculate the permitted energy levels of an electron, in a box 1 A. U wide.
33. Explain the complete parity set.
34. Discuss the negative result of Michelson Morley experiment.
35. How fast should a rocket have to go relative to an observer for is length to be contracted to 99% of its length at rest.
36. Derive Galilean transformation equations.
37. Calculate the kinetic energy of an electron moving with a velocity of 0.98 times the velocity of light in the laboratory system.

SECTION – C
ANSWER ANY THREE QUESTIONS: (3 X 15 = 45)

38. Discuss Davisson and Germer experiment to prove wave particle duality.
39. Deduce the eigen function and energy eigen value for a free particle in a three dimensional box.
40. Explain the commutation relations between parity and symmetric Hamiltonian operators.
41. Derive Lorentz transformation equations and explain its consequence.
42. Deduce the expression for Mass- energy equivalence and explain what is unified mass unit.

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