STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2011-12 & thereafter)

SUBJECT CODE : 11PH/MC/QR64

B.Sc. DEGREE EXAMINATION APRIL 2017
BRANCH III - PHYSICS
SIXTH SEMESTER

REG. No._____

COURSE : MAJOR – CORE
PAPER : QUANTUM MECHANICS AND RELATIVITY
TIME : 30 MINS. MAX. MARKS : 30

SECTION – A
TO BE ANSWERED IN THE QUESTION PAPER ITSELF

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

1. Momentum of photon can be expressed as
   a) h/λ b) h/ν c) h/p d) h ν

2. The group velocity of the wave V_g is given as
   a) dω/dk b) dk/ dω c) dk/d λ d) dk/dp

3. The expectation value of a particle trapped in a box of wide L is
   a) L/2 b) L c) L/4 d) L/8

4. The wave function ψ(x) must approach zero as
   a) x→∞ b) x→−∞ c) x→0 d) both a&b

5. Which of the following wave function is acceptable in quantum mechanics
   a) sinx b) tanx c) cosecx d) $\tan^2 x$

6. An object travelling at speed of light would have
   a) finite mass b) infinite mass c) zero mass d) depends on rest mass

7. If a 4Kg substance is fully converted into energy the energy produced is
   a) $3.6x10^{17}$ J b) $3.6x\ 10^{16}$ J c) $3.6x10^{15}$ J d) $3.6x10^{14}$ J

8. Quantum mechanical operator for total energy in time dependent form
   a) $\frac{ih}{2\pi}\,\partial/\partial t$ b) ih $\partial/\partial t$ c) i $\partial/\partial t$ d) $\partial x/\partial t$

9. A rod 1 meter long moving with a velocity 0.6 c will appear to a stationary observer as
   a) 0.1m b) 0.2m c) 0.8m d) 1m

10. A striking illustration of both time dilation and length contraction occurs in the particle
    a) α b) β c) neutron d) μ meson

11. The speed with which a clock should move so that it may appear to appear to lose 1minute in each hour is
    a) $5.4x10^7$m/s b) $5.4x10^6$m/s c) $5.4x10^5$m/s d) $5.4x10^4$m/s

..2

12. For a particle in a box of length L the general formula for the permitted De broglie wave lengths of the particle is
    a) 2L/n b) n/2L c) 2L/n d) 2n/L

13. The zero point energy of a linear harmonic oscillator is
    a) 1/2 hν b) hν c) 1/2 ν d) 1/2 $h\nu^2$

14. For non-dispersive medium the relation between group velocity (V_g) and velocity (V_p)
    a) $V_g > V_p$ b) $V_g < V_p$ c) $V_g = V_p$ d) V_g is inversely propotional to V_p

15. Parity operator is defined by the relation
    a) Pf(r)=f(-r) b) Pf(r)=f(r) c) Pf(r)=1/f(r) d) Pf(r)=1/f(-r)

II Fill in the blanks:

16. The quantum operator of momentum is _____.
17. Unaccelerated reference frame is _____.
18. A body which appears to be spherical to an observer at rest will appear to be an_____ to a moving observer.
19. The potential energy of a particle outside the box_____.
20. The quantity ψ^2 is called_____.

III State whether true or false:

21. In Newtonian mechanics mass of a body does not depend on velocity of its motion .
22. For dispersive medium group velocity is less than phase velocity.
23. Uncertainity principle can prove the non-existence of electron in the medium.
24. $[x,p_x]=ih$.
25. Davisson and Germer experiment verifies Debroglie hypothesis.

IV Answer briefly:

26. State postulates of special theory of relativity.

27. What does negative result of Michelson-Morley experiment suggest?

28. What is twin paradox?

29. $[x^2, P_x]$ =

30. Write the time dependent Schrodinger equation.

STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2011-12 & thereafter)

SUBJECT CODE : 11PH/MC/QR64

B.Sc. DEGREE EXAMINATION APRIL 2017
BRANCH III - PHYSICS
SIXTH SEMESTER

COURSE : MAJOR – CORE
PAPER : QUANTUM MECHANICS AND RELATIVITY
TIME : 2 ½ HOURS MAX. MARKS : 70

SECTION – B

ANSWER ANY FIVE QUESTIONS: (5 x 5 = 25)

1. Calculate the wavelength of an α-particle accelerated through a potential difference of 2000 volts. Given
   Mass of proton=1.67×10^{-27}Kg
   Planck's constant =6.62×10^{-34}Js.

2. Calculate the energy difference between the ground state and the first excited state for an electron in one dimension rigid box of length 10^{-8}.(m_e=9.1 $\times 10^{-31}$, h=6.6×10^{-34} Js)

3. Normalise the following wave function in one dimension
   $\Psi(x)=Ae^{-\alpha x}$ for $x>0$
   $=Ae^{+\alpha x}$ for $x<0$ where α is positive constant.

4. How fast would a rocket have to go relative to an observer for its length to be contracted to 99% of its length at rest.

5. The rest mass of a electron is 9.1×10^{-31} kg. What will be its mass if it were moving with 4/5 times the speed of light.

6. Explain Lorentz-Fitzgerald length contraction.

7. Obtain the normalized eigen function for a particle in a one dimensional box.

SECTION – C

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

8. Explain Davisson and Germer experiment.

9. Obtain time-independent Schrodinger equation.

10. Obtain the commutation relation for L_X, L_Y, and L_Z, the components of angular momentum operator. Show that L^2 commutes with any of the three components.

11. Explain Michelson-Morley experiment with a neat diagram.

12. Obtain Einstein's mass energy relation.