STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2008-09 & thereafter)

SUBJECT CODE : PH/MC/QR64

B.Sc. DEGREE EXAMINATION APRIL 2012
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. De-Broglie wave length for charged particle of charge q and accelerated through a potential difference of V – volts
   a) $P = \sqrt{2mE_k}$ b) $\lambda = \frac{h}{mv}$ c) $\lambda = \frac{h}{\sqrt{2mqv}}$

2. The Barrier transmission co-efficient has
   a) $\frac{|c|^2}{|A|^2}$ b) $\frac{|B|^2}{|A|^2}$ c) $T = \frac{|D|^2}{|B|^2}$

3. Accelerated frames are called
   a) non-inertial frames b) inertial frames c) Galilean frames

4. The uncertainty principle is
   a) $\frac{\Delta x}{\Delta t} = h$ b) $\frac{d\lambda}{dt} = h$ c) $\Delta x . \Delta p = \frac{h}{4\pi}$

5. The Hamiltonic operator is _____
   a) E=K+V b) $H\psi = E\psi$ c) $\frac{h^2}{2m}\pi^2$

6. The frequency of oscillation of the harmonic oscillator is given by _____
   a) V= $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$ b) $\frac{1}{2}mv^2$ c) $\frac{1}{2}m\,wx^2$

7. The coordinate system chosen to describe motion is known as a _____
   a) special theory of relativity b) frame of reference c) Galilean transformation

8. Unaccelerated reference frame in uniform motion of translation relative to one another are called
   a) inertial frames b) non inertial frames c) Newtonian relativity

9. Relationship between the total energy and the rest energy and the momentum is _____
   a) $E = mc^2$ b) $E^2 = m_0^2c^4 + c^2p^2$ c) $m = \frac{m_o}{\sqrt{1-\frac{v^2}{c^2}}}$

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10. According to Bohr's theory the stable states of electrons in the atom one governed by
a) De-Broglie wave length b) integer rules c) Group velocity

11. The steady state from a Schrodinger's equation in three dimension it is _____
a) $\frac{ih}{2\pi}\ \frac{\partial\varphi}{\partial t}$ b) $\int \psi\psi^* dv = 1$ c) $\Delta^2\psi + \frac{8\pi^2 m}{h^2}(E - V\psi = 0)$.

12. Angular momentum quantum operator is _____
a) $\frac{ih}{2\pi}\nabla$ b) $i\left(\frac{h}{2\pi}\right)\frac{\partial}{\partial t}$ c) $-i\frac{h}{2\pi}\, r\, x\, \nabla$

13. Variation of mass with velocity _____
a) $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$ b) $m_1\sqrt{1-\frac{v^2}{c^2}}$ c) $m_2 = \sqrt{\frac{1-v_2}{c^2}}$

14. A Normalised wave function _____
a) $\int \psi dv = 0$ b) $\int \psi\psi^* dv = 1$ c) $\int \phi^* A(\psi)\, dv$

15. Relation between group velocity (V_g) and phase velocity or wave velocity (V_p) is _____
a) $V_p = \frac{w}{k}$ b) $V_g = \frac{dw}{k}$ c) $V_g = V_p - \frac{V_p}{d\lambda}$

II. FILL IN THE BLANKS:

16. Relation between the total energy, rest energy and the momentum _____

17. Each wave function ψ_n consist of a polynomial $H_n(y)$ called a _____

18. The time interval measured by a clock at rest, relative to the observer is called _____

19. The particle moves without any force acting on it is called a _____

20. The minimum value of the energy of the Harmonic oscillator corresponding to $n = 0$ is _____

III. STATE WHETHER TRUE OR FALSE:

21. This law of addition of velocities applied only when the two velocities are in the same direction.

22. The velocity of light in free space is constant.

23. Particle can be represented by a linear operator.

24. Angular momentum quantum operator is $\int \psi\psi^* dv = 1$.

25. Schrodinger's time independent wave equation is $\frac{\partial^2 y}{\partial x^2} + \frac{8\pi^2 m\epsilon}{h^2}\psi = 0$.

IV. ANSWER THE FOLLOWING:

26. What is meant by meter wave?

27. Explain the tunnel effect.

28. Explain Heisenberg's uncertainty principle.

29. Explain Max Born interpretation of the wave length.

30. Explain the proper time interval.

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TIME : 2 ½ HOURS **MAX. MARKS : 70**

SECTION – B

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

1. Show that the de-Broglie wave length associated with an electron of energy V electron volts is approximately. $\left(1.227/\sqrt{V}\right)nm$.

2. Calculate the rest energy of an electron joules and in electron volts.

3. The equivalent wave length of moving electron is 24 x 10^{-10}m. What voltage applied between two grids will bring it to rest.

4. An atomic particle has a rest mass of 2.5 x 10^{-25}kg find its total mass energy a) when at rest (b) when it has a velocity of 0.9 the speed of light.

5. Derive Hermitian operator.

6. What is the wave length that is associated with an electron.

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

SECTION – C

ANSWER ANY THREE QUESTIONS: **(3 x 15 = 45)**

8. Comment on the significance of the result of communication relation involving the position and momentum operator obtain the commutation relation between angular momentum and position.

9. What is the meaning of mass energy equivalence obtain Einstein's mass energy relation show that $1\ amu = 931 meV$.

10. Describe the Michelson –Morley experiment and explain the physical significance of negative result.

11. Calculate the values of the energy of particle in a one dimensional Box. Indicate graphically the first three wave functions for such a particle.

12. Explain what you understand by the terms potential well and potential barrier. How does a particle with energy lower than the barrier height, tunnel through it? Give one example.