LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

B.Sc. DEGREE EXAMINATION – **PHYSICS**

FIFTH SEMESTER – **NOVEMBER 2014**

PH 5510 - QUANTUM MECHANICS AND RELATIVITY

Date : 30/10/2014 Dept. No. Max. : 100 Marks

Time : 09:00-12:00

PART-A

Answer **ALL** the questions: **(10x2=20)**

1. Mention any two physical phenomena that could not be explained on the basis of classical mechanics.
2. State Heisenberg's uncertainty principle.
3. State any two admissibility conditions on wave function.
4. State any two Born's interpretation of the wave function.
5. What are stationary states?
6. Given $x_{op} = i\hbar\frac{\partial}{\partial p_x}$ and $p_{op} = p_x$, evaluate $\left[x_{op}, p_{op}\right]$.
7. Show that acceleration is invariant under Galilean transformation.
8. State the postulates of special theory of relativity.
9. Find the relativistic kinetic energy of an electron moving with v= $\frac{\sqrt{3}}{2}$ c. Given the rest mass of electron is 0.5 MeV.
10. State equivalence principle.

PART-B

Answer any **FOUR** questions: **(4x7.5=30)**

11. Describe Davisson-Germer experiment.
12. State and prove the Ehrenfest theorem $\frac{d\langle p\rangle}{dt} = -\langle \nabla V\rangle$, the symbols have their usual meaning.
13. State the postulates of quantum mechanics.
14. Solve the problem of a particle in a one dimensional infinite square potential well.
15. From the Lorentz transformation obtain the relativistic velocity transformation rule. Under what condition it reduces to the Galilean one?
16. Explain gravitational red shift.

PART-C

Answer any **FOUR** questions: (**4x12.5=50)**

17. a) Derive an expression for the change in the wave length of a scattered photon, in Compton effect.
    b) Using Heisenberg's uncertainty relation argue that an electron cannot be found inside a nucleus.

18. a) Show that the group velocity is equal to the particle velocity.

    b) Prove that the eigen values of a hermitian operator are real and the eigen functions corresponding to distinct eigen values are orthogonal.

19. Explain Quantum mechanical tunneling. Hence derive an expression for tunneling coefficient across a square potential barrier.

20. a) Obtain an expression for the variation of mass with velocity.
    b) What is the length of a meter scale which moves with a speed v=0.8c.

21. Discuss the following:
    a) Bending of light, b) Gravitational lensing and c) Precision of perihelion of Mercury.

22. Establish the Schrodinger equation for a 1D harmonic oscillator and hence obtain the energy eigen values.

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