



**LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034**

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

**SIXTH SEMESTER – APRIL 2013**

**PH 6609/PH 6605/PH 6603/PH 6600 - QUANTUM MECHANICS & RELATIVITY**

Date : 25/04/2013  
Time : 1:00 - 4:00

Dept. No.

Max. : 100 Marks

**PART-A**

Answer **ALL** the questions:

**(10 x 2=20)**

- 1) Define group velocity.
- 2) State Heisenberg's uncertainty principle.
- 3) Give the Born's interpretation of the wave function.
- 4) What is degeneracy?
- 5) Define Hermitian operator. Give its importance in quantum mechanics.
- 6) Given  $x_{op} = i\hbar \frac{\partial}{\partial p_x}$  and  $p_{op} = p_x$ , evaluate  $[x_{op}, p_{op}]$ .
- 7) State the postulates of special theory of relativity.
- 8) 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.
- 9) State Mach's principle.
- 10) State equivalence principle.

**PART-B**

Answer any **FOUR** questions:

**(4x7.5=30)**

- 11) Describe G.P Thompson 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) Obtain the eigen values of a rigid rotator.
- 14) From the Lorentz transformation obtain the relativistic velocity transformation rule. Under what condition it reduces to the Galilean one?
- 15) Explain gravitational red shift.

**PART-C**

Answer any **FOUR** questions:

**(4x12.5=50)**

- 16) a) Obtain 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 inside a nucleus.

- 17) Obtain the energy eigen values and the energy eigen functions of a one dimensional linear harmonic oscillator.
- 18) a) Prove that the eigen values of a Hermitian operator are real and the eigen functions corresponding to distinct eigen values are orthogonal.
- b) Calculate the degeneracy of a hydrogen atom.
- 19) a) Obtain an expression for variation of mass with velocity.
- b) What is the length of a meter scale which moves with a speed of  $v=0.8c$ ?
- 20) a) Give a heuristic derivation of Einstein's equation in general relativity. Explain the various terms.
- b) Explain briefly the experiments that lend support to Einstein's theory of gravity.

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