

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034



B.Sc. DEGREE EXAMINATION – PHYSICS

SIXTH SEMESTER – APRIL 2018

PH 6609 / PH 6605 / PH 6603 / PH 6600 – QUANTUM MECHANICS & RELATIVITY

Date: 19-04-2018

Dept. No.

Max. : 100 Marks

Time: 01:00-04:00

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) Mention any two admissibility conditions on wave functions.
- 4) Give Born's interpretation of the wave function.
- 5) What are stationary states?
- 6) If $x_{op} = i\hbar \frac{\partial}{\partial p_x}$ 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 any two characteristic features of gravitation theory.
- 10) State equivalence principle.

PART-B

Answer any **FOUR** questions

(4x7.5=30)

- 11) Describe Davisson-Germer experiment and explain its significance.
- 12) State and prove the Ehrenfest theorem $\frac{d\langle p \rangle}{dt} = -\langle \nabla V \rangle$, the symbols having their usual meaning.
- 13) State and explain the postulates of quantum mechanics.
- 14) From the Lorentz transformation equations, obtain the relativistic velocity transformation rule. Under what condition it reduces to the Galilean transformation?
- 15) Explain gravitational red shift.
- 16) With a schematic diagram, explain the principle and working of the electron microscope.

PART-C

Answer any **FOUR** questions

(4x12.5=50)

17) a) Obtain an expression for the change in the wave length of a scattered photon, in the Compton effect experiment.

b) Using Heisenberg's uncertainty relation argue that an electron cannot exist inside a nucleus.

18) Set up and solve the Schrodinger wave equation for a linear harmonic oscillator and obtain its eigenvalues.

19) Solve the radial part of the Schrodinger wave equation for the hydrogen atom and obtain its eigenvalues.

20) a) Obtain the expression for the relativistic variation of mass with velocity.

b) What is the length of a meter scale which moves with a speed $v=0.8c$, parallel to its length.

21) Discuss the following:

a) Bending of light,

b) Gravitational lensing

c) Precision of perihelion of Mercury.

22. What are the postulates of Planck's theory of black body radiation? Obtain an expression for the energy radiated per unit volume as a function of wavelength.
