Model Question Paper

Model 1, Model II and Model III

MAHATMA GANDHI UNIVERSITY

V SEMESTER B.Sc. (Programme) EXAMINATION………YEAR

PH5B01U- CLASSICAL MECHANICS AND QUANTUM MECHANICS

Instructions:
Time allotted: 3 hrs
Answer all questions in part A. This contains 4 bunches of 4 objective questions. For each bunch, grade A will be awarded if all the 4 answers are correct, B for 3, C for 2. D for 1 and E for 0. Answer any 5 questions from part B, any 4 from part C and any 2 from part D.
3. Candidates can use ……………………(type of calculator/tables)

Part A (Objective type- weight 1 each)

Bunch I.

1. The force of constraint (F) does no work in producing virtual displacement (S) because

(a) F and S are parallel (b)F and S are perpendicular
(c) S=0 (d) F=0

2. Einstein's photoelectric equation is based on the law of conservation of
(a) Momentum (b) charge
(c) Mass (d) Energy

3. The conservative nature of a given force F can be tested using

(a) grad F=0 (b) curl F=0
(c) div F=0 (d) F=ma

4 .A system consisting of 3 particles is described in a three dimensional cartesian co- ordinate system. If there are 3 constraints, the number of degrees of freedom of the system is
(a) 3 (b) 6
(c) 9 (d) 12

Bunch II.

5. The quantum mechanical operator for angular momentum is

(a) $-ih\nabla$ (b) $-ih\ \partial/\partial t$

(c) $-ih\ (r \times \nabla)$ (d) $-ih(\nabla \times r)$

6. The physical meaning of normalization of wave function of a particle is that

(a) the wave function is continuous everywhere
(b) the particle exists somewhere in space
(c) the wave function is single valued
(d) the wave function has no significance

7. The wave function of a particle encountering a finite potential step behaves inside the step as if

(a) it is oscillatory
(b) it is exponentially decaying
(c) it is stationary
(d) vanishes at the boundary

8.The value of [x , px] is

(a)ih (b)-ih

(c)-i/h (d)i/h

Bunch III

9. The de Broglie wavelength of an electron having a kinetic energy of 1000eV is…………….

10. The operator in co-ordinate representation for the observable energy is………..

11. If Wi is the probability for occurrence of the eigen value ai in the measurement of the observable A,expectation value <A> =…………

12. For a relativistic particle having a momentum P and Energy E, the group velocity vg=………

Bunch IV

13 For a particle of mass m in a cubical box of side a, the energy of the system E=……….

14. If A and B are operators and AB+BA= 0,then A and B are said to……………

15. Any two eigen functions of a Hermitian Operator that belong to different eigen values are……….

16. The energy eigen values of a rigid operator with quantum number l are E l =…………

Part B (Short answer questions-weight 1 each)

17. What is the principle of least action?
18. Is the Lagrangian formulation more advantageous than the Newtonian formulation? Why?
19. How is quantum theory used to explain Compton effect?
20. Explain the term expectation value of a dynamical variable.
21. Explain the basic requirements of a physically acceptable wave function.
22. Show how you would normalize a given wave function.
23. What do you mean by a stationary state system?
24. Give the one dimensional time independent schrodinger equation for a free particle.

Part C (Short Essay/ Problems- weight 2 each)

25. Find the equation of motion of a simple pendulum using the Lagrangian.

26. If Qk and Pk (k=1,2,3) represent generalized co-ordinates and the corresponding moment of a particle, what is the dimension of phase space and the configuration space?

27.An electron has a speed of 500m/s with an accuracy of 0.004%.Calculate the certainty with which we can locate the position of the electron.(h=6.626 x10-34J/s)

28. Normalize the wave function (x)=A exp(-ax2). A and a are constants over the domain - $\infty \leq x \leq \infty$.

29.If the wave function for a system is an eigen function of the operator associated with the observable A show that <An>=<A>n

30.A harmonic oscillator is in the ground state. Where is the probability density maximum? What is the maximum probability density.?

Part D (Essay type questions- weight 4 each)

31. State and prove Hamilton's principle for a conservative system.

32. Set up the Schrodinger's wave equation for a one dimensional harmonic oscillator. Solve the equation and find the energy eigen values of the oscillator.

33 .Define Probability current density and derive an expression for it.

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