Reg. No.....Name.....

B.SC DEGREE END SEMESTER EXAMINATION OCTOBER 2016

SEMESTER – 5: PHYSICS (CORE COURSE)

COURSE: U5CRPHY5 – CLASSICAL AND QUANTUM MECHANICS

Time: Three Hours Max. Marks: 60

Part A
(Very short answer questions)

(Answer **all** questions) Each question carries **1 Mark**

1. Number of degrees of freedom of a rigid body moving freely in space is
   (a) zero (b) eight (c) four (d) six
2. Planck's constant has
   a) the dimensions of action b) Units of energy multiplied by time
   c) Units of momentum multiplied by length d) Units of angular momentum.
3. If the temperature of the blackbody is halved the wavelength corresponding to the maximum emission of radiation becomes
   (a) 2 times (b) 4 times (c)1/2 times (d)1/4 times
4. A kinetic energy operator in 1 dimension is
   (a) $\frac{-\hbar^2}{2m}\frac{d^2}{dx^2}$ (b) $\frac{-1}{2m}\frac{d^2}{dx^2}$ (c)$\frac{-\hbar^2}{2m}\frac{d^2}{dx^2}$ (d)$\frac{-\hbar^2}{2m}\frac{d^2}{dt^2}$
5. The energy eigen values of a particle trapped in an one dimensional potential well are proportional to
   (a) $\sqrt{n}$ (b) n (c) n^2 (d)n^3
6. In a _____system, the generalized forces are derivable from a potential energy V=V(q_k)
7. The generalized momentum associated with an ignorable or cyclic coordinate is a _____ for the system
8. The ultraviolet catastrophe is associated with _____
9. The rest mass of a photon is _____
10. What is zero point energy?

(1 x 10 = 10)

Part B (Short answer)

(Answer **any Seven** questions) Each question carries **2 Marks**

11. Define the principle of virtual work.
12. Mention two difficulties that arise due to the constraints in the solution of mechanical problems.
13. Show that generalized momentum conjugate to a cyclic co-ordinate is conserved.
14. Why do you say that Compton effect cannot be explained by classical physics?

15. Define Ultraviolet catastrophe.
16. What do you understand by the stationary state?
17. What are well behaved wave functions?
18. Distinguish between phase velocity and wave velocity.
19. Why is the wave nature of matter not noticeable in our daily observations?

(2 x 7 = 14)

Part C (Problem/Derivations)

(Answer **any Four** question) Each question carries **4 Marks**

20. Set up the Hamiltonian and Hamilton's equation of motion for planetary motion.
21. State and Prove D'Alembert's principle.
22. In a series of experiments on the determination of the mass of the ω^0 particle, the results showed a variation of $\pm 20 m_e$, where m_e is the electron mass. What is the lifetime of these particles?
23. What potential difference must be applied to stop the fastest photoelectrons emitted by a surface when electromagnetic radiation of frequency 1.5×10^{15} Hz is allowed to fall on it. The work function of the surface is 5 eV
24. Show that $[L^2, L_z]=0$
25. An electron in a one dimensional infinite potential well goes from the n=4 to n=2 level. the frequency of the emitted photon is 3.43×10^{14} Hz. Find the width of the box.

(4 x 4 = 16)

Part D (Long answer questions)

*(Answer **any Two** question) Each question carries **10 Marks***

26. What is Hamilton's principle? Derive Lagrange's equation for a conservative system using Hamilton's principle.
27. (a) What is Hamiltonian function? Explain its physical significance. Prove that the Hamiltonian H of a conservative system is equal to the total energy of the system.

    (b) Establish Hamiltonian function for linear harmonic oscillator and the equation for the motion of it.
28. What is meant by Compton effect? Derive an expression for the Compton shift.

29. Set up the Schrodinger equation for a one dimensional harmonic oscillator. Solve the equation and hence find the energy eigenvalues of the oscillator.

(10 x 2 = 20)

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