T.Y.B.SC. SEM – V (CBCS - 2016 Course) : WINTER - 2018

SUBJECT : PHYSICS : QUANTUM MECHANICS

Day : Friday
Date : 12/10/2018

Time : 03.00 P.M. To 06.00 P.M
Max. Marks : 60

W-2018-0741

N.B.

1) All questions are **COMPULSORY**.
2) Figures to the **RIGHT** indicate **FULL** marks.
3) Draw neat diagram **WHEREVER** necessary.

Q 1. Attempt any **Two** of the following. **(12)**

(a) Obtain the Schrödinger's time dependent equation.

(b) Prove that $V_g = V_p + k\frac{dv_p}{dk}$ and $V_g = v_p - \lambda\frac{dv_p}{d\lambda}$.

(c) Normalize the wave function $\varphi(x) = \frac{1+ix}{1+ix^2}$ the range of x is from $-\infty \; to \; \infty$.

Q 2. Attempt any **Two** of the following. **(12)**

(a) Check whether e^{2x} is eigen function of operator $\frac{d^2}{dx^2}$. If yes determine the eigen value.

(b) Explain the Davisson and germers experiment to prove wave nature of moving electron.

(c) The wave function of a particle in infinite potential well is given by

$$\varphi_n(x) = \sqrt{\frac{2}{a}}\sin\frac{n\pi x}{a} \; where \; o \leq x \leq a$$ Find <x> and <p_x>.

Q 3. Attempt any **Two** of the following. **(12)**

(a) Find the current density if wave function is $\varphi(x) = Ae^{ikx}$

(b) Prove that $[L^2, L_x] = 0$

(c) Discuss the electron diffraction experiment to illustrate the uncertainty principle .

Q 4. Attempt any **Three** of the following. **(12)**

(a) Show that momentum operator $-i\hbar\frac{\partial}{\partial x}$ is harmitian operator.

(b) Compute the expectation value for $\frac{1}{r}$ in the ground state of the hydrogen atom.

(c) The velocity of ocean wave is given by $\sqrt{\frac{g\lambda}{2\pi}}$, find the group velocity.

(d) Prove the relation $\lambda = \frac{h}{p}$ and hence calculate wavelength associated with particle of mass 2 kg moving with velocity 3.3125 m/s .

Q 5. Attempt any **Four** of the following. **(12)**

(a) Prove the uncertainty relation $\Delta L \Delta\theta \geq \frac{\hbar}{2}$.

(b) Explain the requirements of the wave function .

(c) Prove the Relation $\left[\hat{A}, [\hat{B}, \hat{C}]\right] + \left[\hat{B}, [\hat{C}, \hat{A}]\right] + [\hat{C}, [\hat{A}, \hat{B}]] = 0$

(d) What do you mean degeneracy of the energy level ?

(e) State parity of function $\varphi(r, \theta, \emptyset) = \cos\theta \, e^{-ar}$

(f) A small object of mass $1\mu g$ is confined to move between two rigid masses separated by distance 1 mm. Calculate the minimum speed of object.

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