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Reg. No. : .....

Name : .....

Fifth Semester B.Sc. Degree Examination, October 2015
First Degree Programme under CBCSS
PHYSICS
Core Course
PY 1542 : Quantum Mechanics

Time : 3 Hours Total Weightage : 30

SECTION – A

[This Section contains **four** bunches **each** of **four** questions. Answer **all** questions. **Each** bunch carries a weightage of **one**.]

I. Select the best choice among the options.

1) This effect was explained by Einstein,

a) Photoelectric b) Compton

c) Raman d) Dirac-Kapitsa

2) Planetary atom model was first put forward by,

a) Bohr b) Rutherford

c) Thomson d) Dalton

3) According to uncertainty principle

a) $\Delta x \Delta p \geq \frac{h}{4\pi}$ b) $\Delta x \Delta p \geq \frac{h}{2\pi}$

c) $\Delta x \Delta p \leq \frac{h}{4\pi}$ d) $\Delta x \Delta p \geq h$

4) For a simple harmonic oscillator with classical frequency f, energy is given by

a) $E = hf$ b) $E = hf\left(n + \frac{1}{2}\right)$

c) $E = \frac{1}{2}hf$ d) $E = hf(n + 1)$

P.T.O.

II. Answer in **one** word/sentence :

5) What is a quanta/particle of light ?

6) Write down the time independent Schrodinger equation for a one dimensional harmonic oscillator.

7) Write down the commutation relation between x and p.

8) What is De Broglie formula for wavelength ?

III. Fill in the blanks :

9) To explain black body radiation _____ proposed the idea that energy is quantized.

10) Wave nature of material particles such as electron was first proposed by _____

11) Max Born suggested that $\psi^* \psi$ be interpreted as _____ density.

12) In wave mechanics, the evolution with time of the wave function is given by the _____ equation.

IV. State whether the following statements are **true** or **false** :

13) Strictly speaking, Newton's law are not valid for microscopic objects as small as atoms.

14) According to Rutherford atom model angular momentum of electron is quantized.

15) According to Quantum Mechanics, wave function of a particle can't be directly observed.

16) According to Quantum Mechanics, energy of a harmonic oscillator can take only certain discrete values.

SECTION – B

[Answer **any eight** questions. **Each** question carries a weightage of **one**.]

17. What is Compton effect ?

18. State correspondence principle.

19. What do you mean by probability density ?

20. What is meant by normalization of wave function ?

21. Write a short note on uncertainty principle.

22. State Bohr postulates.

23. Write a note on the experimental confirmation of matter waves.

24. What are the advantages of Bohr atom model over Rutherford model ?

25. Write a brief note on statistical interpretation.

26. What is a linear vector space ?

27. Define the Dirac delta function.

28. What do you mean by a finite square well potential ? Explain with a neat diagram.

SECTION – C

[Answer **any five** questions. **Each** question carries a weightage of **two**.]

29. Show that Bohr's hypothesis of quantization of angular momentum is consistent with de Broglie formula for wavelength of matter waves.

30. Show that the operator $-i\frac{d}{dx}$ is a Hermitian operator defined over the space of square integrable functions.

31. Calculate the energy carried by a photon of wavelength 500 nm. (Planck's constant, $h = 6.6 \times 10^{-34}$ Js, velocity of light, $c = 3 \times 10^8$ m/s).

32. If the Hamiltonian of a system is, $H = (p^2/2m) + V(x)$, obtain the value of the commutator [x, H].

33. Use de Broglie formula to calculate the momentum of a photon of wavelength 500 nm.

34. Consider an electron in a one-dimensional infinite potential well of width 1 nm. Calculate the separation between the two lowest energy levels and the wavelength of the photon corresponding to a transition between the two energy levels, (Planck's constant, $h = 6.6 \times 10^{-34}$ Js, Velocity of light, $c = 3 \times 10^8$ m/s, mass of electron $m = 9.1 \times 10^{-31}$ kg).