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Name.....

Reg. No.....

FIFTH SEMESTER B.Sc. DEGREE (SUPPLEMENTARY/IMPROVEMENT)
EXAMINATION, NOVEMBER 2016

(UG—CCSS)

Physics

PH 5B 10—QUANTUM MECHANICS

(2013 Admissions)

Time : Three Hours

Maximum : 30 Weightage

1. Objective questions (Answer *all* questions) :

1. The low frequency limit to Planck's law is :

- | | |
|-------------------|-------------------------|
| (a) Wien's law. | (b) Rayleigh-Jeans law. |
| (c) Newton's law. | (d) Boyle's law. |

2. Compton effect confirms :

- | | |
|--------------------------------|-----------------------------------|
| (a) Wave nature of radiation. | (b) Particle nature of radiation. |
| (c) Particle nature of matter. | (d) Wave nature of matter. |

3. Photons possess :

- (a) Gravitational mass only.
- (b) Rest mass only.
- (c) Both gravitational and rest mass.
- (d) No mass at all.

4. Electron microscopes employ :

- | | |
|-----------------------------------|-------------------------------|
| (a) Particle nature of protons. | (b) Wave nature of protons. |
| (c) Particle nature of electrons. | (d) Wave nature of electrons. |

5. When the number of waves forming a wave packet is increased, what happens to the width of the wave packet ?

- | | |
|--------------------|-----------------------|
| (a) Becomes wider. | (b) Becomes narrower. |
| (c) Becomes zero. | (d) Becomes infinity. |

Turn over

6 Franck-Hertz experiment confirms :

- (a) Pauli's exclusion principle.
- (b) De Broglie hypothesis.
- (c) Discreteness of atomic energy levels.
- (d) Spin of electron.

7 The quantum mechanical operator for energy is _____.

- (a) $-i\hbar \frac{\partial}{\partial x}$
- (b) $i\hbar \frac{\partial}{\partial x}$
- (c) $-i\hbar \frac{\partial}{\partial t}$
- (d) $i\hbar \frac{\partial}{\partial t}$

8 Among the following, which system has energy levels equally spaced ?

- (a) Hydrogen atom.
- (b) Particle in a box.
- (c) Harmonic oscillator.
- (d) Rigid rotator.

9 The magnetic quantum number is related to the conservation of :

- (a) Mass.
- (b) Angular momentum magnitude.
- (c) Angular momentum direction.
- (d) Energy.

10 For the principal quantum number 3, which among the following is a possible value for the orbital angular momentum quantum number ?

- (a) 0.
- (b) 1.
- (c) 2.
- (d) 3.

11 The space-quantization of electron spin was first demonstrated by _____ experiment.

12 The momentum expectation value of a particle enclosed in a box is _____.

(12 × 14 = 3 weights)

II. Short answer questions (Answer all questions) :

- 13 Draw the spectrum of a black body.
- 14 What is gravitational red shift ?
- 15 Discuss the probability interpretation of the wavefunction.
- 16 Explain the terms phase velocity and group velocity.
- 17 What are the basic postulates in Bohr's atom model ?

- 18 Discuss the effect of nuclear mass on the atomic spectral lines.
- 19 What are the essential conditions on a wavefunction ?
- 20 What do you mean by the term zero point energy of a harmonic oscillator ?
- 21 State Pauli's exclusion principle.

(9 × 1 = 9 weightage)

III. Short essay questions (Answer any *five* questions) :

- 22 X-rays of wavelength 10 p.m. are Compton scattered from a metal block. Determine the maximum wavelength present in the scattered rays.
- 23 Determine the de Broglie wavelength of an electron accelerated through a potential difference of 100 V.
- 24 An eigen function of the operator $\frac{d^2}{dx^2}$ is e^{2x} . Find the corresponding eigen value.
- 25 A particle moving in one dimension has the wavefunction $\psi = \alpha x^2$ in the interval $x = 0$ and $x = 1$ and zero elsewhere. Find the expectation value of the position of the particle.
- 26 Compare a quantum mechanical harmonic oscillator to its classical counterpart.
- 27 A proton in a one-dimensional box has energy 400 keV in its first excited state. Determine the width of the box.
- 28 Explain normal Zeeman effect.

(5 × 2 = 10 weightage)

IV. Essay questions (Answer any *two* questions) :

- 29 What is photoelectric effect ? Discuss the experimental findings and give Einstein's explanations.
- 30 Discuss the Bohr's theory of hydrogen atom and explain the various spectral series.
- 31 Discuss the theory of quantum mechanical tunneling.

(2 × 4 = 8 weightage)