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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

I 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.

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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 × ¼ = 3 weightage)

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 ?

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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 $\psi = ax^2$ 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)

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