

D 11553

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Name.....

Reg. No.....

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

(UG—CCSS)

Physics/Applied Physics

PH 5B 10/AP 5B 12—QUANTUM MECHANICS

(2009—2012 Admissions)

Time : Three Hours

Maximum : 30 Weightage

Section A

Answer all questions.

Each question carries $\frac{1}{4}$ weightage.

1. The problem of ultraviolet catastrophe was predicted by :
 - (a) Stefan Boltzmann law.
 - (b) Planck's law.
 - (c) Wien's law.
 - (d) Rayleigh Jeans law.
2. When the intensity of light incident on a metal surface is increased, the photoelectric current :
 - (a) Decreases.
 - (b) Increases.
 - (c) Remains.
 - (d) Becomes zero.
3. In Compton scattering the incident photon loses maximum energy to the electron when the photon is scattered at :
 - (a) 0 degree.
 - (b) 180 degrees.
 - (c) 90 degrees.
 - (d) 45 degrees.
4. If a proton and an electron have the same de Broglie wavelength then :
 - (a) Both have same kinetic energies.
 - (b) Proton has more KE than electron.
 - (c) Electron has more KE than proton.
 - (d) Both have same velocity.
5. The particle and wave aspects of a physical entity are :
 - (a) Perturbations.
 - (b) Complementary.
 - (c) Non complimentary.
 - (d) None of these.

Turn over

6. Davisson Germer experiments confirm the existence of :
- (a) Matter waves.
 - (b) Electromagnetic waves.
 - (c) Gravitational waves.
 - (d) Black body radiation.
7. Stern Gerlach experiment gives a direct confirmation of :
- (a) Space quantization.
 - (b) Spin of electron.
 - (c) Wave nature of electron.
 - (d) Quantized atomic magnetic moment.
8. The ground state energy of a hydrogen electron is :
- (a) 13.6 Joules.
 - (b) 13.6ev.
 - (c) - 13.6ev.
 - (d) - 3.4ev.
9. According to Schrödinger a particle is equivalent to a :
- (a) Single wave.
 - (b) Wave pocket.
 - (c) Light wave.
 - (d) None of these.
10. Of the following moving with the same velocity which has the largest wavelength ?
- (a) Photon.
 - (b) Neutron.
 - (c) α particle.
 - (d) Electron.
11. According to wave machine a free particle can possess :
- (a) Discrete energies.
 - (b) Only one single value of energy.
 - (c) Continuous energies.
 - (d) All these.
12. Which *one* of the following pairs of phenomena illustrates the particle aspect of wave particle duality ?
- (a) Compton effect and Bragg's law.
 - (b) Photo electric effect and Compton effect.
 - (c) Compton effect and Pauli's exclusion principle.
 - (d) Photo electric effect and Bragg's law.

(12 \times $\frac{1}{4}$ = 3 weightage)

Section B

Answer all questions.

Each question carries 1 weightage.

- 13 Under what conditions does the average energy of a quantum oscillator & classical oscillator coincide. Reason your answer.
- 14 Low frequency light cannot trigger photoelectric effect. Why ?
- 15 What are the conservation laws satisfied in a Compton scattering experiment ?
- 16 Distinguish between Phase velocity and group velocity.
- 17 What intrinsic property of electron is reflected in the fine structure splitting of spectral lines of hydrogen like atoms ?
- 18 Show that eigen values of a Hermitian operator are real.
- 19 Explain zero point energy.
- 20 Distinguish between allowed transitions and forbidden transitions.
- 21 Why is it that a particle in a three dimensional box requires three quantum numbers for its description ?

(9 × 1 = 9 weightage)

Section C

Answer any five questions.

Each question carries 2 weightage.

- 22 Find the average energy in eV of a Planck's oscillator of frequency 1.9×10^{14} Hz at 1527°C (Assume $e^5 = 148$).
- 23 Describe Millikan's experiment for the verification of Einstein's photoelectric equation.
- 24 Light of wavelength 4500\AA ejects photo electrons from a sodium surface of work function 2.3eV . The stopping potential is experimentally found to be 0.46 volts. Calculate Planck's constant.
- 25 A free electron at rest is struck by a photon of wavelength 0.5 nm. Calculate its speed after collision if the photon is scattered backwards. (Assume electron motion is non relativistic)
- 26 Calculate the de Broglie wavelength of a 1 keV electron and 1 keV proton.
- 27 Explain spin orbit interaction example.
- 28 Explain Zeeman splitting of the sodium D lines in a weak magnetic field.

(5 × 2 = 10 weightage)

Section D

Answer any two questions.

Each question carries 4 weightage.

- 29 What is Compton effect ? Derive an expression for the frequency shift of protons as a function of the angle of scattering for Compton effect using energy momentum conservation.
- 30 Explain Bohr's postulates of the atomic structure. Derive expressions for the radius of the Bohr orbit and total energy of the hydrogen atom.
- 31 Derive the Schrödinger's equation for a linear harmonic oscillator and solve it to obtain the eigen values and eigen functions.
- 32 What is space quantization ? Describe Stern Gerlach's experiment. How does it prove the existence of magnetic moment and electron spin ?

(2 × 4 = 8 weightage)