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 ¼ 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 looses 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 posses' :

(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 part 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 × ¼ = 3 weight

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°A 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 1kev 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)