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Name....................

Reg. No....................

FIFTH SEMESTER B.Sc. DEGREE EXAMINATION, NOVEMBER 2015

(U.G.—CCSS)

Core Course—Physics/Applied Physics

PH 5B 10/AP 5B 12—QUANTUM MECHANICS

(2009–2012 Admissions)

me : Three Hours

Maximum : 30 Weightage

Section A

Answer all questions.

1. Which law explains distribution of radiant energy against wavelength for the whole spectral range ?

    (a) Wien's law.
    (b) Rayleigh Jean law.

    (c) Planck's law.
    (d) Maxwell distribution law.

2. In which type of electromagnetic radiation is the photoelectric effect dominant ?

    (a) X-ray.
    (b) R-ray.

    (c) Microwave.
    (d) Visible and ultraviolet.

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. Matter waves are :

    (a) Electromagnetic transverse waves.

    (b) Longitudinal waves.

    (c) Waves produce in a medium.

    (d) Neither longitudinal nor transverse waves.

5. The wavelength of matter waves is given by :

    (a) $\lambda = h/mv$
    (b) $\lambda = h/v$

    (c) $\lambda = hv/m$
    (d) $\lambda = hm/v$

6. An electron microscope can magnify objects by :

    (a) 10 x.
    (b) 1/10 x.

    (c) 500 x.
    (d) 5 x.

Turn over

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. For a hydrogen atom the stationery Bohn orbits :
   - (a) Are not stable classically.
   - (b) Are stable.
   - (c) Can be derived.
   - (d) None of these.

9. Which of the following statement is most correct ?
   - (a) Each eigen function belongs to only one eigen value.
   - (b) One or more eigen functions may belong to one eigen value.
   - (c) Eigen functions belonging to different eigen values are orthogonal.
   - (d) All these.

10. The zero point energy of harmonic oscillator is :
    - (a) $\hbar \omega$.
    - (b) $\frac{1}{2} \hbar \omega$.
    - (c) $2 \hbar \omega$.
    - (d) $\frac{1}{4} \hbar \omega$.

11. According to wave mechanics a free particle can possess :
    - (a) Discrete energies.
    - (b) Only one single value of energy.
    - (c) Continuous energies.
    - (d) All these.

12. The quantum operator for angular momentum is :
    - (a) $\frac{P^2}{2m}$.
    - (b) $I \omega$.
    - (c) $\frac{-i\hbar}{2\pi} \times \nabla$.
    - (d) $\nabla \times \bar{r}$.

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

Section B

Answer all questions.
Each question carries 1 weight.

13. What is a photon ? Which statistics do photons obey ?
14. Low frequency light cannot trigger photoelectric effect. Why ?
15. Explain, why Compton scattering does not allow electron to recoil at angle greater than 90 degree.
16. What is Pair production ?

17. What are the postulates of wave mechanics ?

18. Give Bohr's correspondence principle.

19. How is the total energy of a hydrogen related to the principle quantum no. ? Explain the significance of the negative sign in the energy equation.

20. Explain, what is meant by normalization of a wave function.

21. Distinguish between allowed transitions and forbidden transitions.

$(9 \times 1 = 9$ weightage)

Section C

Answer any **five** *questions.*

22. Discuss Planck's quantum hypothesis and deduce Planck's law of energy distribution for black body radiation.

23. What is Photoelectric effect ? What are its characteristics ? What are the difficulties encountered in explaining photoelectric effect classically ?

24. Light of wavelength 4500 A° ejects photoelectrons from a sodium surface of work function 2.3 eV. The stopping potential is experimentally found to be 0.46 volts. Calculate Planck's constant.

25. In a Compton scattering experiment an incident radiation of wavelength 0.2408 nm in the direction 180 degree w.r.t. the incident direction. Find the wavelength of the radiation.

26. What is Gravitational red shift ? Obtain an expression for gravitational red shift.

27. Explain how the quantum numbers are defined in vector atom model.

28. Explain Zeeman splitting of the sodium D lines in a weak magnetic field.

$(5 \times 2 = 10$ weightage)

Section D

Answer any **two** *questions.*

29. Describe the Davisson Germer experiment to prove the existence of matter waves.

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. Give the theory of finite potential well. Draw the figure representing the wave functions and probability density.

32. What is space quantization ? Describe Stern Gerlach's experiment. How does it prove the existence of magnetic moment and electron spin ?

$(2 \times 4 = 8$ weightage)