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**Reg. No. : ....................................**

**Code No. : 30315 E** **Sub. Code : SMPH 62**

B.Sc. (CBCS) DEGREE EXAMINATION, APRIL 2022

Sixth Semester

Physics — Core

QUANTUM MECHANICS

(For those who joined in July 2017 onwards)

Time : Three hours Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

Choose the correct answer :

1. The value of Planck's constant h is

   (a) $6.226\times10^{-27}$ joule – sec

   (b) $6.626\times10^{-27}$ erg – sec

   (c) $6.226\times10^{-34}$ erg – sec

   (d) $6.626\times10^{-34}$ joule – sec

2. In photoelectric effect, light behaves as

   (a) particle (b) wave

   (c) radiation (d) heat

3. Which one can't be explained by wave theory of light?

   (a) Black body radiation

   (b) Compton effect

   (c) Photoelectric effect

   (d) All the above

4. The two different waves which form a group of waves are

   (a) same in amplitude; same in velocity

   (b) different in amplitude; same in velocity

   (c) same in amplitude; different in velocity

   (d) different in amplitude; different in velocity

5. When the position coordinate of a diffracted particle in motion is accurately determined, which one is true?

   (a) $\Delta x=0$ (b) $\Delta x\geq\hbar$

   (c) $\Delta p=0$ (d) $\Delta p\geq\hbar$

6. Where is the maximum intensity observed in Fraunhoffer diffraction pattern?

(a) in upper band (b) in central band

(c) in bottom band (d) in all the bands

7. Quantum operator of angular momentum

(a) $-ihr \times \nabla$ (b) $ihr \times \nabla$

(c) $i\hbar \times \nabla$ (d) $-i\hbar\nabla$

8. Hamiltonian operator is

(a) $\frac{h}{2m}\nabla^2 + v$ (b) $\frac{h^2}{2m}\nabla^2 + v$

(c) $\frac{-h}{2m}\nabla^2 - v$ (d) $\frac{-h^2}{2m}\nabla^2 + v$

9. Outside the box, the value of a wave function is

(a) 1 (b) infinity

(c) zero (d) undetermined

10. When does the potential energy be zero in a potential barrier?

(a) $L < x < 0$ (b) $x = 0$

(c) $x < L$ (d) $L > x > 0$



PART B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 250 words.

11. (a) Draw and describe the energy distribution curves of a black body at temperatures of 998 K, 1259K, 1449K and 1646K.

Or

(b) A metallic surface emits electrons with energies upto 0.6 eV and 2.04 eV, when illuminated with a light of wavelength 3333 Å and 2400 Å respectively. Calculate the work function of the metal.

12. (a) Derive the relationship between group velocity and phase velocity.

Or

(b) Calculate the wavelength of a wave associated with an electron having energy of 1 MeV.

13. (a) Give the physical significance of position-momentum uncertainty relation.

Or

(b) A microscope located an electron in an atom within a distance of 0.2 Å. Calculate the uncertainty in momentum of that electron.

14. (a) Prove : $\langle p_x x\rangle - \langle x p_x\rangle = \frac{\hbar}{i}$.

Or

(b) Physically interpret the wave function $\psi$.

15. (a) Calculate the permitted energy levels of an electron in a box of $1\times10^{-10}$m wide.

Or

(b) Obtain the normalized wave function for the motion of a particle in 1-D box.

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b).

Each answer should not exceed 600 words.

16. (a) Describe the experimental study of the photoelectric effect and results. How did classical physics fail to explain this effect?

Or

(b) Explain the Compton effect.

17. (a) Determine $v_g$ and $v_p$ for a particle moving at relativistic and non-relativistic speeds.

Or

(b) Demonstrate the wave nature of electrons by Davison and Germer's experiment.



18. (a) Calculate the radius of the first Bohr orbit as a consequence of uncertainty relation.

Or

(b) State Heisenberg's uncertainty principle. Prove that $\Delta L.\Delta\phi \geq \hbar$.

19. (a) Prove that uncertainty principle for 1-D wave packet.

Or

(b) Evaluate he quantum operators for Hamiltonian, total energy and angular momentum.

20. (a) Explain the finite square well potential and draw the wave functions for the first three allowed energy levels.

Or

(b) Calculate the Eigen values of the total energy for simple harmonic oscillator. Draw the potential energy curve. Obtain the general formula for the nth wave function.

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