CSM : 22

PHYSICS

PAPER - II

Time Allowed : 3 hours | Full Marks : 100

Marks for each question is indicated against it.
Attempt <u>any 5 (five)</u> questions taking not more than 3 (three) questions from each Part.

PART - A

1. (a) Explain the concept of wave particle duality. State de-Broglie hypothesis of matter waves. Why we cannot observe de-Brogile wavelength associated with macroscopic objects? **(3+3+3=9)**

(b) State Heisenberg's uncertainty principle. Describe one experiment to illustrate the validity of this principle. **(2+4=6)**

(c) If the position of a particle is determined within 0.05 mm, What will be the uncertainty in its momentum? **(5)**

2. (a) What is an operator in quantum mechanics? Write the operators for linear momentum and kinetic energy. **(2)**

(b) For a particle confined in a one-diamensional box: **(12)**

(i) Show that the wave functions of two different states are orthonormal.

(ii) Discuss the zero-point energy

(iii) Obtain the expectation values for x and p_x.

(c) Show that $\left[\hat{x}, \hat{p}_x\right] = i\hbar$ **(6)**

3. (a) Describe normal and anomalous Zeeman effect. How was the degeneracy of Hydrogen atom explained using Zeeman effect? **(8)**

(b) Using Pauli spin matrices prove that **(8)**

(i) $\sigma_x\sigma_y + \sigma_y\sigma_x = 0$

(ii) $\sigma_+\sigma_- = 2(1+\sigma_z)$

(c) Show that Pauli Spin Matrices anti-commutes each other. **(4)**

4. (a) Discuss the vibrational spectra of a molecule treating it as an anharmonic oscillator. **(12)**

(b) In observing the Raman spectra of a sample using an excitation line at 3637 Å, one observes a Stokes line at 3980 Å. Deduce the Raman shift? **(8)**

PART - B

5. (a) Describe the various contributions to the binding energy of a nucleus, and hence obtain the semi-empirical mass formula for the mass of a nucleus as a function of A and Z. Discuss its application in predicting the stability of a nuclei against beta decay. **(7+4=11)**

(b) Discuss Meson theory of nuclear forces. **(4)**

(c) Calculate the nuclear radii for ^{14}N, ^{56}Fe. Given = R_o=1.2 Femi. **(5)**

6. What are quarks? Give the charge and quantum number associated with each quark. Describe the composition of hadrons according to quark model. **(3+3+5=11)**

(b) Identify the following interaction from the conservation laws:

$\sum^0 \rightarrow \Lambda^0 + \gamma$ (life time $\leq 10^{-14}$s) **(4)**

(c) Construct proton and neutron from their quark content? **(5)**

7. (a) Show that the reciprocal lattice for a 'bcc' lattice is a 'fcc' structure. **(8)**

(b) Deduce Miller indices of the close packed plane of atoms in the 'fcc' lattice. **(6)**

(c) What is Debye temperature? **(6)**

8. (a) Implement the Boolean function $X = AB + \bar{A}C$ using NAND gates. **(10)**

(b) Calculate the pinch-off voltage for nn-channel silicon FET with a channel width of 6×10^{-4} cm^{-3}. Given that dieletric constant of silicon is 12. **(10)**

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