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CMDQ/M-20 5652

NUCLEAR PHYSICS-II

Option (ii)

PHY-403B

Time : Three Hours] [Maximum Marks : 60

Note : Attempt *Five* questions in all, selecting *one* question from each Unit. Q. No. **1** is compulsory.

1. (a) Define scattering length. What is the significance of its sign ? **3**

(b) Explain the experimental demonstration of Bohr's hypothesis of compound nuclear reaction. **3**

(c) Using extreme single particle model predict the ground state electric quadrupole moment of :

(i) ^{16}O

(ii) ^{17}O

(iii) ^{17}F nuclei. **3**

(d) Express $Y_{2,-2}$ (θ, φ) in terms of the Cartesian components of the unit vector in the direction (θ, φ). **3**

Unit I

2. (a) Discuss in detail the exchange mechanism of nuclear interaction. **6**

(b) Derive an expression for *n-p* scattering cross-section within the framework of effective range theory. **6**

3. (a) Obtain expressions of scattering cross-section for scattering of neutrons by ortho and para hydrogen. Hence show that the nuclear interaction is spin dependent. **6**

(b) Calculate the magnetic dipole moment of deuteron in its ground state. Assume that the ground state of deuteron is a pure $^3D_1$ state. **6**

Unit II

4. (a) Derive expressions for scattering and reaction cross-sections in the channel of *l*th partial wave. Show that when the phase shift is purely real only scattering occurs. **6**

(b) Derive the formula $\sigma_{SC} = \sum_l (2l+1)\frac{\pi}{k^2}\left[A_l(pot) + A_l(res)\right]^2$ with $A_l(pot) = e^{-2i\xi_l}$ and $A_l(res) = \frac{-2iK_l}{f_l - S_l - iK_l}$. All the symbols have their usual meanings. Show that $A_l(pot)$ corresponds to scattering by an impenetrable sphere of radius R. **6**

5. Explain evidences in favour of direct nuclear reactions. Using Born approximation derive an expression of stripping cross-section. **12**

Unit III

6. (a) Discuss the salient features of Bohr-Wheeler theory of nuclear fission. **6**

(b) Predict the first seven magic numbers for an isotropic harmonic oscillator potential. **6**

7. (a) Discuss the prediction of nuclear spin on the basis of nuclear shell model of nuclei having arbitrary number of nucleons in a level. Explain pairing hypothesis and seniority wave function. **6**

(b) Derive expressions of Schmidt values of magnetic dipole moment of nucleons. Show that the magnetic dipole moment of a closed shell nucleus is zero. **6**

Unit IV

8. (a) Show that the dipole deformation leads to the translation of the centre of mass of the nucleus. **6**

(b) Describe in detail the quantization of a harmonic quadrupole oscillator. **6**

9. (a) For a deformed nucleus, show that mean square charge radius is given by $\left\langle r^2 \right\rangle = \frac{3}{5} R_0^2 + \frac{3}{4\pi} R_0^2 \left\langle \beta^2 \right\rangle$. Symbols have usual meanings. **6**

(b) Discuss the atomic nucleus as a symmetric rotor. **6**