RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. SIXTH SEMESTER EXAMINATION, MAY 2019

THIRD YEAR [BATCH 2016-19]

Date : 10/05/2019 **PHYSICS (Honours)**

Time : 11 am – 1 pm **Paper :** VII (Group - A) Full Marks : 50

Answer **any five** questions of the following: [5 × 10]

1. a) State and explain the cross section of nuclear reaction. Give its geometrical significance. (2+2)

   b) Explain why heavy nuclei are more fissionable than the lighter one. (2)

   c) Calculate the energy released in the fusion of two $^{12}C_6$ nuclei. Use the mains formula [Given (in MeV unit) : $a_v = 15.75,\ a_s = 17.92,\ a_A = 23.51$ and $a_p = 33.5$] (4)

2. a) State and explain Bohr's hypothesis of the formation of compound nucleus and its subsequent decay. Describe an experiment verifying this hypothesis. (3+3)

   b) Define threshold energy of a nuclear reaction. (1)

   c) Write down the reaction for He formation from protons. Calculate the Q value of the reaction. (1+2)

3. a) Explain the occurrence of magic nuclei using shell model of nuclei. (2)

   b) Explain energetics of nuclear fusion using LDM and show that the condition for spontaneous fusion is $Z^2/A > 51$ (2+3)

   c) Comment which of the two uranium isotopes is more fissionable than the other. What is nucleosynthesis? (2+1)

4. a) Discuss the principle of phase stability. (3)

   b) Obtain the betation condition $\frac{d\phi}{dt} = 2\pi r^2 \frac{dB}{dt}$, where the symbols have their usual meaning. (5)

   c) Calculate the energy of emergent proton from a cyclotron, given magnetic field is 0.72 Wb/m^2 and extreme radius is 1 m. (mass of proton = 1.673×10^{-27}kg) (2)

5. a) In a series disintegration $A \rightarrow B \rightarrow C$ (stable), show that if $A_0\lambda_A$ is constant activity of a very long lived source, the number of atoms of C collected in a time t is given by :

$$C = A_0\lambda_A\left[t - \frac{1}{\lambda_B}\left(1 - e^{-\lambda_B t}\right)\right] = A_0\lambda_A t - B$$ (4)

   b) A mean range of $^{210}P_0$ α - particles (E = 5.3 MeU) in an at NTP is 0.03842 m. Find its range in aluminium (A=27, density = 2700 kg/m^3). What is staggering of range of α - particles? (3+1)

   c) Explain why, unlike α - particles, β - particles are not emitted with a single energy. (2)

6. a) Compare between the cross sections for different interactions of γ - ray with matter. Why is β decay called a weak process? (3+1)

b) What are dominant multiples in the following gamma- ray transactions : (3)

i) $\left(\frac{1}{2}\right)^{-} \rightarrow \left(\frac{3}{2}\right)^{+}$

ii) $2^{+} \rightarrow 1^{+}$

iii) $2^{+} \rightarrow 1^{-}$

c) Show that in the process of β - decay the conservation of angular momentum breaks down.

7. a) Which of the following interctions are allowed or disallowed? Explain with reasons. (4)

i) $\bar{\wedge}^{+} + p \rightarrow \sum^{+} + \bar{\wedge} + K^{0}$

ii) $\bar{\wedge}^{-} + p \rightarrow \sum^{-} + \bar{\wedge}^{+}$

iii) $e^{-} + e^{+} \rightarrow \mu^{-} + \mu^{+}$

iv) $e^{-} + p \rightarrow u_{\mu} + n$

b) $\Delta(1232)$ is a pion-nucleon $(\bar{\wedge} - N)$ resonance of iso spin $\frac{3}{2}$. What are its different charge states? (2)

c) Consider a rotationally invariant system in three dimensions. How does an energy eigenstate of such a system transform under parity? (4)

8. a) What do you mean by charge conjugation? Find the charge parity of a photon. Show that invariance under charge conjugation does not allow a decay of $\bar{\wedge}^{0}$ to an odd number of photons. (4)

b) Find the quark content of the following particles. (2)

i) Λ^{0} ii) p iii) K^{+} iv) $\bar{\wedge}^{-}$

c) A pion at rest decays into a muon and a neutrino. Write down the decay scheme. Using 4 vector formulation find the energy of the neutrino in terms of the masses of $\bar{\wedge}$ and μ . (4)

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