RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. SIXTH SEMESTER EXAMINATION, MAY 2016

THIRD YEAR [BATCH 2013-16]

Date : 02/05/2016 **PHYSICS (Honours)**

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

Group - A

***Answer <u>any five</u> of the following* :** [5×10]

1. a) What is meant by straggling of range of alpha particle? What are the reasons behind it? [1+2]
   b) A radio-nuclide emits alpha particles of energy 4·8 MeV and has a half-life 1620 years. Compute the probability of alpha emission. Given, mass of alpha particle = 4·0026 u, radius of the nucleus = $7{\cdot}9 \times 10^{-15}$ m. [2]
   c) Explain why the beta-ray spectrum is continuous. [5]

2. a) What is meant by binding fraction? Draw the graph showing the variation of binding fraction with mass number. Show, with the help of the curve, that energy is expected to be released both when light nuclei are fused together and heavy nuclei undergo fission. [1+1+2]
   b) Explain mirror nuclei method for determining the size of nucleus. [4]
   c) Compute the binding energy of last proton in a nucleus of ^{12}C if the mass of ^{12}C nucleus is 12·00052 a.m.u, mass of ^{11}B nucleus is 11·01996 a.m.u and the mass of proton is 1·00759 a.m.u. [2]

3. a) Obtain an expression for the binding energy and mass of a nucleus in the ground state on the basis of semi empirical mass formula of Weizsäcker. [4]
   b) What is 'weak interaction paradox' of single particle shell model? How was the paradox finally resolved? [3]
   c) Explain the role of spin-orbit coupling to explain the magic numbers in the shell model of nucleus. [3]

4. a) What is Q-value of nuclear reaction? Obtain an expression for the Q-value of the reaction $a+A \rightarrow b+B$ in terms of incident energy masses of the four participation in the reaction and the scattering angle. [4]
   b) Obtain an expression for the differential cross-section of a nuclear reaction in terms of the incident flux, scattering angle, number of scattering centers and the contrast of the reaction product. [3]
   c) In a reaction $^{7}Li(p,\alpha)\alpha$, the incident proton of energy 0·25MeV led to emission of two alpha particles each of energy 8·6MeV. Calculate the momentum of each alpha particles
   [Given : masses of alpha = 3724 MeV, ^{7}Li = 6520 MeV] [3]

5. a) Obtain an expression for the recoil energy of a gamma-emitting nucleus. Is it justify to neglect this? [3]
   b) What are the dominant multiplies in the following gamma-ray transition?
   i) $\frac{3^+}{2} \rightarrow \frac{1^-}{2}$ ii) $\frac{Q^+}{2} \rightarrow \frac{Q^+}{2}$ iii) $3^- \rightarrow 0^+$ [3]
   c) A nucleus emits gamma ray of energies 110 KeV, 129 KeV, 285 keV, 414 keV and 524 keV. Construct a possible level scheme of the nucleus. [4]

6. a) An electron is accelerated to an energy 100 GeV. To what length scale can it probe the structure of another particle on which it is allowed to make a collision? [2]

b) Which of the following interactions are allowed and which are not? Give reasons. [6]

i) $\mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu$

ii) $p \rightarrow e^+ + \pi^0$

iii) $\pi^- + p \rightarrow K^+ + \pi^- + \Lambda^0$

iv) $\pi^- + p \rightarrow K^- + \pi^+ + \Lambda^0$

v) $\pi^- + p \rightarrow \Sigma^+ + K^-$

vi) $\Lambda^0 \rightarrow p + \pi^- + \pi^0$

c) Give the quark structure of the following hadrons. (i) $\bar{p}$ (ii) π^+ (iii) Λ^0 (iv) Σ^-. [2]

7. a) What is the Gell-Mann-Nishijima scheme? What is the iso-spin of Λ^0? Show that it satisfies the scheme. [2]

b) $\Delta(1232)$ is an I-spin 3/2 resonance which decays strongly into pions and nucleons. From iso-spin invariance of strong interactions, find the relative rates of decays of $\Delta^+ \rightarrow p\pi^0$ and $\Delta^0 \rightarrow p\pi^-$. [6]

c) Find the threshold kinetic energy of a proton colliding with another proton at rest in laboratory to produce an antiproton in a minimal interaction. Mass of proton ~1 GeV/c^2. [2]

8. a) Explain the working principle and phase stability operation in synchrotron. [5]

b) Discuss the quenching in Geiger Muller counter. What is non-self-quenching? [5]

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