



WEST BENGAL STATE UNIVERSITY
B.Sc. Honours 5th Semester Examination, 2021-22

PHSADSE03T-PHYSICS (DSE1/2)

NUCLEAR AND PARTICLE PHYSICS

Time Allotted: 2 Hours

Full Marks: 50

*The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.*

Question No. 1 is compulsory and answer any two from the rest

1. Answer any *fifteen* questions from the following: 2×15 = 30
- What is mirror nuclei? Give example.
 - ${}^2\text{He}^4$ nucleus has no magnetic moment. Explain.
 - Determine the radii of a ${}^{16}\text{O}$ nucleus, given $r_0 = 1.2$ fm
 - State Geiger-Nuttall law.
 - Find the Q-value of the reaction ${}^{14}_7\text{N}(\alpha, p){}^{17}_8\text{O}$. Take mass of ${}^4\text{He} = 4.0026$ u, ${}^{14}\text{N} = 14.0031$ u, ${}^1\text{H} = 1.0078$ u, ${}^{17}\text{O} = 16.9994$ and $1\text{u} = 931$ Mev.
 - A muon is not a meson. Explain.
 - Calculate the minimum speed of a charged particle for emission of Cerenkov radiation in a medium of refractive index 1.5.
 - What are the differences between Compound nuclear reaction and direct reaction?
 - What is strangeness of an elementary particle?
 - How does interaction of γ -ray in matter differ from interaction of charged particles?
 - What are packing fraction and binding energy fraction?
 - What are the quark contents of proton and neutron?
 - What is straggling of range of α -particle?
 - An ultra-relativistic proton moves in a magnetic field. Can it radiate π^+ , π^- and π^0 mesons, electrons and positrons?
 - Why the following reactions are not found in nature?
 - $e^- \rightarrow e^- + \gamma$ in vacuum
 - $K^+ \rightarrow \pi^+ + \gamma$ in vacuum
 - Can photoelectric emission take place with free electron? Explain.
 - Give example of two hyperons. What is hyper nucleus?
 - Define parity of a nucleus.
 - What is resonant reaction?
 - Why neutron show magnetic moment though it lacks charge?

2. (a) 1 g of ^{226}Ra has an activity of 1 curie. Calculate the mean life and half life of Radium. 3
- (b) What are the problems to explain continuous β -decay spectrum? How they were solved? 3
- (c) Why U^{235} is fissile with slow neutrons but U^{238} requires fast neutrons for fission process? 4
3. (a) Why spin-orbit coupling is necessary in Shell model to reproduce magic numbers? 3
- (b) What are the spin-parity (J^π) of ${}_4\text{Be}^{11}$ in its ground state? 1
- (c) What are the basic assumptions behind Fermi gas model of the nucleus? 2
- (d) Calculate the threshold energy for the nuclear reaction ${}^{14}\text{N}(n,\alpha){}^{11}\text{B}$ in MeV. Use the following data: 4
 Mass of ${}^{14}\text{N}$ (14.007550 u), mass of n (1.008987 u), mass of α (4.003879 u), mass of ${}^{11}\text{B}$ (11.012811 u).
4. (a) Explain how the Wave theory failed to explain photoelectric effect and Compton effect. 2
- (b) What are the major interaction processes by which energized electron loses energy within matter? Explain them. 4
- (c) How fast neutrons interact with matter? 2
- (d) Why $e^- - e^+$ pair production cannot occur in vacuum? 2
5. (a) What is meant by SU(3) symmetry of strong interaction? How is this broken? 4
- (b) Write CPT conservation law. 2
- (c) The isospin, baryon number and strangeness of a particle are given by $I = 0$, $B = +1$ and $S = -3$, respectively. Find the electric charge of the particle. 2
- (d) Identify the type of the reaction 2
- (i) $\mu^- \rightarrow e^- + \nu + \bar{\nu}$
- (ii) $\Sigma^0 \rightarrow \Lambda^0 + \Lambda$

N.B. : Students have to complete submission of their Answer Scripts through E-mail / Whatsapp to their own respective colleges on the same day / date of examination within 1 hour after end of exam. University / College authorities will not be held responsible for wrong submission (at in proper address). Students are strongly advised not to submit multiple copies of the same answer script.

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