

End Semester Examination, 2022**Semester - V****Physics****PAPER - DSE-2T***Full Marks : 60**Time : 3 Hours*

The Figures in the right hand margin indicate marks. Candidates are required to give their answers in their own words as far as practicable.

Group - A

- 1. Answer any ten questions : **10x2=20****
- a) An α -particle of energy 5 Mev is scattered through 180° by a fixed Uranium nucleus. Calculate the distance of closest approach. 2
- b) "A GM counter cannot be used to detect the neutrons". Explain the statement. 2
- c) Find spin & parity for ground state of ${}_{32}^{63}\text{Ge}$, using the shell model. 1+1
- d) Explain that k-shell electron is more probable during photoelectric emission by γ -ray. 2
- e) What do you meant by 'cerenkov radiation, process ? 2
- f) What is nuclear isomerism ? Explain with example. 2

(Turn Over)

- g) A μ^- meson decays into an electron (e^-) and pair of neutrinos. Calculate the maximum available energy for the process and the average electron energy. 2
- h) Calculate the mass of Pb^{214} (RaB) having a radio-activity of 1 curie. Half-life of Pb^{214} is 26.8 minutes. 2
- i) Electrons are accelerated to get maximum kinetic energy in a cyclotron under the influence of a magnetic field of 3.2 Wb/m^2 . Calculate the frequency of the evolution of the emerging electron. 2
- j) What are mirror nuclei? 2
- k) Discuss the role of electric quadrupole moment to determine the shape of the nuclei. 2
- l) Out of ${}_3Li^6$, ${}_3Li^8$, ${}_4Be^9$ and ${}_4Be^{10}$, which nucleus more stable? 2
- m) Identify the unknown particle in the reactions given below using conservation laws. 2
- i) $p + ? \rightarrow {}_0^1n + \gamma_\mu$
- ii) $\Pi^- + p \rightarrow k^0 + ?$
- n) Describe the existence of the 'color' quantum number. 2
- o) A GM counter has a dead time $400 \mu\text{s}$. What is the true counting rate when observed rate 100 per minute. 2

Group - B**Answer any four questions : 4x5=20**

2. a) Establish the relation $A \approx 2Z$ for light nuclei using semi-empirical mass formula given $a_c = 0.71 \text{ MeV}$, $a_n = 22.7 \text{ MeV}$, $M({}_1^1H) = 1.0078U$, $M(n) = 1.0086$ unit. 3+2
- b) What are the advantages of semiconductor counters over gas filled detectors.(counters). 3+2
3. a) Explain the principle of action of a scintillation counter. 3+2
- b) For the isobaric family with $A=75$, find the most stable isobar. (Using the liquid drop model) 3+2
4. a) Assuming the collision to be elastic, show by using the Q equation that the kinetic energy K_x of the target particle is given by,
- $$K_x = 4K_x \frac{m_x M_x}{(m_x + M_x)^2} \cos^2 \theta.$$
- b) For ${}_{11}^{23}Na$, ${}_{82}^{206}Pb$ nucleus find out numbers of U and d quarks. 3+2
5. a) Explain qualitatively how the neutrino hypothesis solve the apparent breakdown of conservation of momentum; spin and energy in β decay. 3+2
- b) Define the range of an α -particle. How did Geiger related the range with energy? 3+2

6. a) What do you mean by mass defect and binding energy of nucleus? Draw a curve showing the variation of binding energy per nucleon against the mass number. 1+1+1
 b) Using the relation between mass number and nuclear radius $R = 1.3 \times A^{1/3} \text{Fm}$, estimate the density of nuclear matter. 2
7. a) What do you mean by internal conversion? 2
 b) A beam of ν -rays from ThC'' is incident normally on an ${}_{13}\text{Al}^{27}$ sheet of uniform thickness 48 cm, which reduces the intensity of the incident beam to 15% of its original value. Calculate the mass absorption coefficient aluminium. (density of aluminium is 2.65 gm/c.) 2+3

Group - C

Answer any two questions : 2 x 10 = 20

8. a) Write down the assumption of Fermi gas model.
 b) What are the successes of the fermi gas model.
 c) Which of following reaction are allowed or not and find out which type of reaction.
 i) $\Pi^+ + n \rightarrow K^+ + \Sigma^0$
 ii) $k^- + p \rightarrow \bar{k}^0 + n$
 iii) $n \rightarrow p + e^- + \bar{\gamma}_e$
 d) Why do not all heavy nuclei show auto fission? 3+2+3+2

9. a) What do you mean by nucleosynthesis? How does the $A < 60$ nuclei are formed after Big-bang?
 b) What is r-process and s-process?
 c) Explain the difference between an ionisation chamber, a proportional counter and a Geiger Muller counter. What is dead time of GM counter? 4+2+4
10. a) What is mass parabola? How does mass parabola explain the stability of nuclei of same isobar. 1+2
 b) Determine the possible values of the spin of Π^- meson by means of the reaction, $\Pi^- + p \rightarrow n + \gamma$ 2
 c) What is Compton effect? 1
 d) Derive an expression for Compton shift in wavelength. 4
11. a) Explain the action of a Van-de-Graff generator by drawing a neat sketch of the machine. 4
 b) What are the design parameters for a cyclotron that would accelerate a particles to a maximum energy of 20 MeV? The dees are to have a diameter of 1m. 2
 c) What do you mean by octet symmetry? Demonstrate the octet symmetry of baryons in a weight diagram. 2+2