



B.Sc. (Semester – V) Examination, April 2019

PHYSICS (Paper – III)

Nuclear Physics

Duration : 2 Hours

Max. Marks : 80

Instructions : 1) **All** questions are **compulsory**.

2) Figures to the **right** indicate **maximum** marks.

3) **Use** of log tables and calculator is permitted.

4) Symbols have their usual meaning unless specified.

1. Answer **any four** of the following :

16

a) Discuss the properties of nucleus :

1) Size and Shape

2) Parity.

b) What is artificial radioactivity and how does it differ from natural disintegration ?

c) Describe the construction and working of Alpha ray mass spectrometer.

d) State the merit and demerit of nuclear reactors over conventional energy sources.

e) From the following data determine the decay constant of radioactive isotope :

Time (months)	0	2	4	5.5	6	9	10	14	18
Disintegration/sec	1260	794	500	454	315	158	125	50	20

f) It is proposed to use the nuclear fusion reaction ${}_1\text{D}^2 + {}_1\text{D}^2 = {}_2\text{He}^4$ in a nuclear reactor of 200 MW rating. If the reactor has to run with just 25% efficiency, how many gram of deuterium will be needed per day ?

[Mass of ${}_1\text{D}^2 = 2.0141$ a.m.u. and mass of ${}_2\text{He}^4 = 4.0026$ a.m.u.)

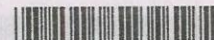
2. Answer **any four** of the following :

16

a) What is meant by packing fraction ? Draw packing fraction curve and explain its utility.

b) Alpha particle spectrum exhibits a fine structure and beta particle spectrum is continuous. Explain why ?

c) What are the basic assumptions made in the nuclear shell model ? How they are different than those made in liquid drop model ?



- d) Describe the working of ionization chamber along with its schematic diagram.
- e) A sample of ancient document is found to have 0.78 the C^{14} activity of the living plant. If half life of C^{14} is 5730 yr, calculate the age of the document.
- f) How many alpha and beta particles are emitted when Uranium $_{92}U^{238}$ decays into $_{82}Pb^{208}$?

3. A) p) What do you mean by electrical quadrupole moment ? What is the physical significance of this quantity ? 3

q) What is Yukawa potential and why it is known as the one pion exchange potential ? 3

OR

A) x) Why was there need to define a new kind of force among constituents of nucleus ? 3

y) Define nuclear magnetic moment. How much is the nuclear magnetic moment of even-even nuclei ? 3

B) What is the difference between central force and non-central force ? Explain how the information about electric quadrupole moment of Deuteron proved the non-central nature of nuclear force. 6

4. A) p) Explain the origin of short range and long range alpha particles with the help of neat energy level diagram. 3

q) A patient having 4 liters of blood is administered intravenously a dose of 4 milli curie of Na^{24} of half life 15 hours. Find the activity in 1 ml of blood withdrawn from patient 2.5 days after dose is given. 3

OR

A) x) Give Fermi's golden rule for beta decay i.e. probability of emission beta decay in the momentum interval. Explain briefly each factor involved. 3

y) Discuss important applications of radioactivity. 3

B) In a radioactive series an element A decays into an element B which further decays into a stable product C. Using law of radioactive decay and assuming their respective different decay constant, prove that number of radioactive atoms at any instant of B is given by 6

$$N_B = \frac{\lambda_A N_A^0}{\lambda_B - \lambda_A} [e^{-\lambda_A t} - e^{-\lambda_B t}]$$



5. A) p) Draw a graph of potential energy of two fission fragments as a function of distance between its' two centers explain how activation energy is computed. 3
- q) What are magic numbers ? State the evidences for the existence of magic numbers. 3

OR

- A) x) Draw energy level diagram for ${}^7_3\text{Li}$ showing the filling of the levels by neutrons and protons. What is the spin of these nuclei in their ground state ? 3
- y) In neutron induction fission of ${}^{235}_{92}\text{U}$ nucleus two stable end products usually found are ${}^{98}_{42}\text{Mo}$ and ${}^{136}_{54}\text{Xe}$. Which type of radioactive decay the original products have undergone ? How many neutrons are emitted ? 3
- B) Discuss how nuclear shell model predicts spin and parities in the ground state of nuclei with even as well as odd mass number. 6
6. A) p) Discuss the role of moderator and coolant in nuclear reactors. 3
- q) What do you mean by quenching in Geiger Mueller tube ? Why it is necessary ? 3

OR

- A) x) Discuss the concept of nuclear chain reaction. 3
- y) Define :
- 1) Dead time
 - 2) Recovery time and
 - 3) Paralysis time in the context of Geiger Mueller tube. 3
- B) Describe neutron cycle in a thermal nuclear reactor and show how it leads to the four factor formula. 6
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