



Rollno.....

End Semester Examination, December 2024
B.Sc. (H) Physics – Vth Semester
Nuclear and Particle Physics (BSPH309A)

Time: 2.5 hrs.

Max Marks: **50**

Note: **All Questions are compulsory.** Marks are indicated against each question.

PART-A

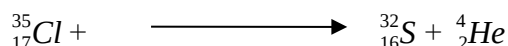
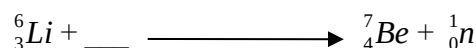
Q.1 Attempt any five questions:

- (a) The radius of Ho^{165} is 7.731 fm. Deduce the radius of He^4 . [CO-1] [L-1] **2**
- (b) Show that the nuclear density is the same for all the nuclei. [CO-1] [L-2] **2**
- (c) Why do stable nuclei usually have more neutrons than protons? [CO-1] [L-1] **2**
- (d) If energy of the α -particle emitted by Am^{241} is 5.48 MeV, find the closest distance it can approach Au nucleus. [CO-1] [L-3] **2**
- (e) Use the single particle shell model to predict the ground state spins and parities of $^{16}_8\text{O}$ and ^7_3Li . [CO-1] [L-1] **2**
- (f) The electronic structure is known before the nuclear structure. Explain why? [CO-1] [L-1] **2**
- (g) What is the significance of the binding energy versus mass number curve? [CO-1] [L-2] **2**

2x5

PART-B

Q.2 (a) Complete the following nuclear reaction:



- (a) Distinguish between compound nucleus reaction and direct reaction with example.
- (b) What is Geiger-Nuttall law? In some alpha spectra, instead of one discrete line, several closely spaced discrete lines are observed. Why? [CO-2] [L-2] **10**

OR

- (a) When does a nucleus undergo gamma decay? State the basic difference between internal conversion and photoelectric effect and between internal pair conversion and pair production.
- (b) Define nuclear reaction cross-section. In what unit it is measured? The cross section and the number of atoms per cubic meter for cadmium, ^{113}Cd for capturing thermal neutrons are $2 \times 10^{-24} \text{m}^2$ and

5.58×10^{27} atoms/m³ respectively. What thickness of cadmium is needed to absorb 99 percent of an incident beam of thermal neutrons? Is cadmium an efficient absorber of thermal neutrons?

[CO-2] [L-2] **10**

Q.3 (a) What is a scintillation detector? With the aid of a labelled diagram, explain the construction and working of a photomultiplier tube.

(b) Distinguish between the Bremsstrahlung radiation and Cerenkov radiation. Calculate the threshold velocity of electrons to produce Cerenkov radiation in a medium of refractive index 1.52

[CO-3] [L-3] **10**

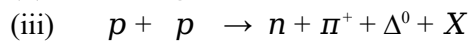
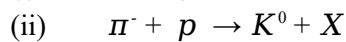
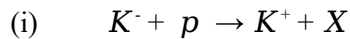
OR

(a) Briefly explain the principle, construction and working of a GM counter. What is its dead time and recovery time?

(b) Compare the photoelectric effect and Compton scattering in terms of the interactions between the incident photons and the target matters.

[CO3] [L-3] **10**

Q.4 (a) Given that the following reactions are all strong interactions, use the relevant conservation laws to identify the attributes/quantum numbers of the unknown particle X. Hence, identify X.



(b) Compute the ratio of, as well as the magnitudes of the maximum energy of protons, deuterons, and alpha

particles, that can be obtained from a cyclotron of 75 cm radius, with a magnetic field strength of 1.4 T.

[CO-4] [L-2] **10**

OR

(i) What is the working principle of a Van-De-Graff accelerator? What are the limitations of Van-De-Graff accelerator? How can they be overcome in Tandem accelerator?

(ii) Discuss the quark model and explain how mesons and baryons are formed using quarks.

[CO- 4] [L-2] **10**

Q.5 (a) Using the semi-empirical mass formula, find the condition for most stable isobar for a given A.

(b) What are nuclear magic numbers? Write the basic assumptions of nuclear shell model. [CO-1] [L-3]

10

OR

(a) Discuss the Fermi model for the nuclear charge distribution.

(b) Explain with a graph, the variation of binding energy per nucleon versus mass number. Explain nuclear fission and nuclear fusion from binding energy per nucleon graph.

[CO- 1] [L-3]

10