

QP CODE: 26801770



Reg No :

Name :

INTEGRATED M.Sc. DEGREE EXAMINATION, APRIL 2026

Eight Semester

INTEGRATED M.Sc. BASIC SCIENCES-PHYSICS

CORE - IPH8CR04 - NUCLEAR PHYSICS - II

2021 Admission Onwards

ECFF4BCB

Time: 3 Hours

Weightage: 30

Part A (Short Answer Questions)

*Answer any **eight** questions.*

Weight 1 each.

1. Why is a vacuum necessary in the E/M determination apparatus for alpha particles?
2. Which method is commonly used to determine the velocity of an alpha particle?
3. Which property of particles allows magnetic spectrographs to separate them?
4. What are the two types of neutrinos involved in beta decay?
5. Which equation relates energy and wavelength for electromagnetic waves?
6. What is a solid-state detector?
7. What is meant by the dead time of a GM counter?
8. In which detector are the particle tracks permanent and can be analyzed later?
9. Define isospin, and what is the isospin of a proton and a neutron?
10. Rutherford scattering led to which experimental discovery? Why is Rutherford scattering called elastic scattering? What assumption is made about the nuclear forces in Rutherford scattering? Briefly comment on the experimental setup of Rutherford scattering.

(8×1=8 weightage)

Part B (Short Essay/Problems)

*Answer any **six** questions.*

Weight 2 each.

11. Define the range of alpha particles and explain the factors affecting it.
12. Define alpha disintegration energy and explain how it is calculated using mass defect.
13. State the significance of quantum tunneling in the context of alpha decay.





14. Differentiate between nuclear isomers and isotopes.
15. Differentiate between an ionization chamber and a proportional counter.
16. Describe the construction and working of a Wilson cloud chamber.
17. Consider quantum nuclear scattering,
 - (a) Write the formula for elastic cross section (σ_{es}), total cross section (σ_{tot}), and reaction cross section (σ_r).
 - (b) Suppose $\eta_l = 1$ for all l . Show that the reaction cross section $\sigma_r = 0$.
 - (c) Now suppose for a single partial wave $l = 2$, $\eta_2 = 0.5$, all others have $\eta_l = 1$. Find σ_r if $k = 0.8\text{fm}^{-1}$.
18.
 - (a) Compare and contrast compound-nucleus and direct reactions. Discuss the time scale and angular distribution of emitted particles.
 - (b) Why do isotropic angular distributions typically characterize compound nucleus reactions? What does this suggest about the lifetime of the compound nucleus?
 - (c) In a nuclear reaction $X(a,b)Y$, it is observed that particle 'b' is emitted mostly in the forward direction. What type of reaction is it likely to be - compound or direct? Justify your answer.

(6×2=12 weightage)

Part C (Essay Type Questions)

Answer any **two** questions.

Weight 5 each.

19. Discuss the nature of the beta ray spectrum, the reasons for its continuous distribution, and the role of neutrinos in conserving energy and momentum in beta decay.
20. Describe the Mössbauer effect in detail, including the concept of recoil-free emission and absorption of gamma rays, and explain the conditions under which it occurs.
21. Compare scintillation counters with gas-filled detectors (ionization chamber, proportional counter, GM counter) in terms of construction, sensitivity, and use.
22. Explain neutron thermalization, its significance for fission reactions, and the significance of the term 'thermalization'. Explain quantitatively why water is a good moderator.

(2×5=10 weightage)

