M.Sc Examination, 2023

(2nd Year, 2nd Semester)

Physics

Nucleus Under Different Conditions

Paper: PG/SC/CBS/PHY/TH /402

Time: Two hours   Full Marks: 40

Answer any four questions:

1. a) What do you mean by spin-orbit coupling in the context of Nuclear Shell Model? Show that splitting of energy levels due to this coupling increases with "l".

   b) Find the average magnetic moment $<\mu_z>$ for ^{17}O nucleus using extreme single particle shell model. Deduce the required formula.

   c) For $^{61}Ni_{28}$ nucleus, extreme single particle model predicts spin-parity to be $(5/2)^-$ whereas, observed value is $(3/2)^-$. Explain.   [(1+3)+4+2]

2. a) Discuss how one can assign an error to a single count in a nuclear counting experiment. What should be done to reduce the error to approximately its one fourth value?

   b) Counts from two gamma sources are as follows;

   Source 1 : N_1 = 625 in 5s

   Source 2 : N_2 = 900 in 5s

   Back-ground Count = 100 in 10s

   Find the ratio of activities of the two sources along with its error.

   c) What is Luminosity? Why is it important in a high energy experiment? On what factors does it depend in a collider experiment?   [(2+2) + 3 + 3]

3. a) What do you mean by threshold energy in the context of relativistic collision?

b) Particle A of energy E hits particle B at rest, producing particles C1, C2, ..., in the reaction A+B → C1 + C2 + ... + Cn.
Calculate the threshold energy for this reaction in terms of various particle masses.

c) A high energy proton strikes a proton at rest, creates a proton-antiproton pair in addition to the original particles. Determine the threshold energy for this reaction and comment on the velocity of projectile proton.

d) What is rapidity variable? Show that it transforms as additive over Lorentz transformation.

[1+3+(2+2)+2]

1. a) Why collider experiment is advantageous over fixed target experiment?
Compare the available CMS energy for fixed target and collider experiment in case of proton - proton collision at 7 TeV. What are the challenges of collider experiment?

b) Name the main parts of LHC detectors and mention their primary goal and position with respect to collision point. Briefly discuss the working of anyone part.

[(1+3+1)+(3+2)]

5. a) What do you mean by de-confinement of quarks? Define the new state of matter produced after the de-confinement of quarks and mention its essential features.

b) Why do we need to study such new state of matter in laboratory?

c) What are the primary signals that indicate the presence of such new state of matter? Discuss about any two signals?

[(2+2)+1+(1+4)]

5. a) Define cross section for collider experiment and fixed target experiment, then explain its physical meaning.

b) Consider a scattering of an incoming wave by a central potential field V(r). Calculate the scattering amplitude and then angular differential cross section using partial wave analysis.

c) For low energy s-wave scattering calculate the total cross section.

d) Discuss the possible effects of spin dependent nature of **n-p** interaction in **n-p** scattering process.

[3+4+1.5+1.5]