Register Number:

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ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. PHYSICS - IV SEMESTER
SEMESTER EXAMINATION : APRIL 2017
PH 0216 : NUCLEAR AND PARTICLE PHYSICS

Time: 2 1/2 hours **Maximum Marks:70**

This question paper contains 2 parts and 2 printed pages.
Use of Clark's tables and scientific calculators permitted.

Instructions : *Draw appropriate figures wherever necessary.*

PART - A

Answer any 5 questions. Each carries 10 marks. (5 x 10 = 50)

1. Explain the design, principle and working of an NaI scintillation detector. (10)

2. a) Which are the four basic kinds of interactions? Mention the carriers of these interactions.
   b) Write a note on the conservation laws which govern the interactions of subatomic particles. (2+8)

3. Write the equation for a typical alpha decay process. What is the mechanism through which an alpha decay happens? Using the basic conservation theorems obtain an expression for the kinetic energy of the daughter nucleus. (1+2+7)

4. a) Differentiate among n-n, p-p and n-p interactions. Which among these is the ideal one to study the properties of nuclear force? Why?
   b) With reasoning, identify the energy terms contributing to the semi empirical formula for the binding energy of a nucleus. (5+5)

5. a) Differentiate between compound nucleus and direct reactions.
   b) What are resonances?
   c) Give the general expression for a nuclear reaction. What is the meaning of the terms scattering cross section and differential scattering cross section? If it is desired to obtain a particular product after the reaction, would you prefer a high/low value for the scattering cross section? Why? (3+2+5)

6. a) Write a note on the properties of pi mesons.
   b) List a few particles with a non-zero value for the strangeness quantum number.
   c) Write down the properties of strangeness quantum number and strange particles.
   d) What is CPT theorem? (3+2+2+3)

7. a) Obtain an expression for the binding energy of a nucleus in terms of atomic masses.
   b) Using the result of question (a) obtain the expressions for (i) proton separation energy and (ii) neutron separation energy.
   c) What is mass parabola? (4+4+2)

PART - B

Answer any 4 questions. Each carries 5 marks. (4 x 5 = 20)

8. Analyze the following reactions according to their quark content.

$$\Omega^- \rightarrow \Lambda^0 + K^- \qquad\qquad K^+ \rightarrow \pi^+ + \pi^0$$

9. If the energy of the alpha particle emitted by ^{231}Am is 5.48MeV, find the closest distance to which it can approach a $^{194}_{79}Au$ nucleus.

10. Find the angle between the angular momentum vector $\boldsymbol{l}$ and the z-axis for all possible orientations when $\boldsymbol{l}$ = 4.

11. Calculate the height of the potential barrier faced by an alpha particle inside a $^{226}_{88}Ra$ nucleus.

12. It is known that the specific activity of $^{14}_{6}C$ nuclide in some ancient wooden item is 3/5 of that in lately fallen trees. The half life of $^{14}_{6}C$ is 5570 years. Determine the age of the wooden item.

13. Calculate the electric field at the surface of the wire of a GM counter. The radius of the wire is 0.1mm, the inner radius of the outer cylinder is 2cm and the potential applied between the two electrodes is 1000V.