Register Number:

DATE:

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. a) Differentiate between Coulomb scattering and nuclear scattering. Which are the ideal particles to perform these scattering experiments? Why?
b) Can we accelerate neutrons as we do with charged particles? If yes, explain how. If not, suggest alternative methods to get neutrons with desired energies. (5+5)

2. Explain the design, principle and working of a cyclotron. (10)

3. a) Write a note on the properties of nuclear force.
b) The radius of a nucleus can be specified using either of the two nuclear properties. Which are these properties? Are they producing different values for the nuclear radius? Why? What can be inferred from this result? Which property of the nuclear force is being strongly supported from this result?
c) Explain the terms mean radius and skin thickness for a nucleus. (3+4+3)

4. Write a description on the CP violation in the decay of K mesons. (10)

5. a) Write a short note on extreme single particle model (shell model).
b) What are magic numbers?
c) Show that with the inclusion of spin-orbit coupling, the shell model could successfully reproduce the magic numbers. (2+2+6)

6. a) What are quarks? Write a note on the properties of quarks.
b) Why do quarks require a color quantum number?
c) Draw the Feynman diagram for electron positron annihilation into quarks.
d) How does a quark interact with another quark? Give an example. (2+3+3+2)

7. a) What is radioactivity? Obtain the radioactive decay law and hence obtain an expression for the activity of a radioactive sample. Experimentally, how can the activity be measured?
b) Draw a typical response of a detector to mono-energetic gamma rays. Identify the features in the response and mention its source. (5+5)

PART - B

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

8. Calculate the Coulomb barrier for the fission of a ^{238}U nucleus into two $^{119}_{46}Pd$ nucleus. Assuming that the binding energy of ^{238}U is about 7.6 MeV/nucleon and that for $^{119}_{46}Pd$ is about 8.5 MeV/nucleon, say whether the fission is energetically possible or not with reasons.

9. Calculate the ground state spin and parity of $^{17}_{8}O$, $^{21}_{10}Ne$, $^{41}_{20}Ca$

10. Three radioactive sources each have activities of 1.0 μCi at t=0. Their half lives are, respectively, 1.0s, 1.0h and 1.0day. How many radioactive nuclei are present at t=0 in each source? How many nuclei of each source decay between t=0 and t=1 sec?

11. The five highest energy alphas emitted by ^{242}Cm have energies (in MeV) of 6.113, 6.070, 5.972, 5.817, 5.609. Each state is connected with the state directly below it by a gamma transition. Calculate the energies of the gamma rays.

12. Find which of the following reactions are forbidden by one or more conservation laws. Give all violated laws in each case.

$$\pi^- + p \rightarrow \Sigma^+ + K^- \qquad \pi^- + n \rightarrow K^+ + \Lambda^0$$

13. Which isobar of A=79 does the liquid drop model suggest as the most stable nucleus?