Register Number:

DATE:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. PHYSICS – IV SEMESTER
SEMESTER EXAMINATION : APRIL 2018
PH 0216 : NUCLEAR AND PARTICLE PHYSICS

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

This question paper contains 3 printed pages and 2 parts
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) Which are the different types of nuclear reactions?

   b) What is meant by (i) cross section, (ii) differential cross-section, (iii) reaction cross-section and (iv) total cross-section

   c) Draw in your answer sheet the variation of binding energy per nucleon with nucleon number. In the light of this plot, explain in which region will nuclei undergo (i) fission and (ii) fusion.

   (3+4+3)

2. a) Describe the concept of nuclear radius.

   b) With the help of a suitable diagram, explain the method of mass spectrometry. Mention one application of it.

   (3+7)

3. a) Draw the response of a gamma detector to monoenergetic gamma rays and label the features.

   b) Explain the principle and working of a semiconductor detector.

   (3+7)

4. a) Write the expression for shell model potential with explanation of variables. Draw its graphical representation in your answer sheet.

   b) Was this potential adequate to explain the observed magic numbers? Explain.

   (4+6)

5. a) Write a note on the properties of π mesons.

b) Explain the term 'resonance particles'. Name a few meson resonances.

c) Look at the following reactions. $\begin{array}{c}\pi^+ + p \rightarrow \rho^+ + p \\ \downarrow \\ \pi^+ + \pi^0\end{array}$ and $\pi^+ + p \rightarrow \pi^+ + \pi^0 + p$. The particles observed in either case are the two pions and the proton. How is it possible to distinguish the reaction in which the ρ^+ particle is formed and then decays?

(2+3+5)

6. a) Discuss Standard model in particle physics.

b) What is Feynman diagram? Draw the Feynman diagram for the quark structure in the decay $\Delta^{++} \rightarrow p + \pi^+$

(6+4)

7. a) Draw the kinetic energy spectrum of electrons produced during a beta decay.

b) Discuss Fermi theory of beta decay.

(2+8)

PART – B

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

8. The ground state of ^{207}Pb nucleus has spin parity $\frac{1}{2}^-$, while for the first excited state, it is $\frac{5}{2}^-$. Identify the type of electromagnetic radiation emitted when the nucleus makes a transition from the first excited state to the ground state.

9. Find the Q values of the following decays. For each decay, calculate the kinetic energy of the daughter nucleus.

(i) $^{247}Bk \rightarrow {}^{243}Am + \alpha$, (ii) $^{251}Cf \rightarrow {}^{247}Cm + \alpha$

(2.5+2.5)

10. Assuming a magnetic field of 1.4 T, compute the maximum energy of (i) protons, (ii) deuterons and (iii) α particles that can be obtained from a cyclotron of 75 cm radius.

11. A photon is Compton scattered off a stationary electron through an angle of 45° and its final energy is half its initial energy. Calculate the value of the initial energy in MeV.

12. Radium being a member of the uranium series is found in uranium ore. If the half lives of uranium and radium are respectively 4.5 x 10^9 and 1620 years, calculate the relative proportions of these elements in a uranium ore, which has attained equilibrium and from which none of the radioactive products have escaped.

13. Which of the following reactions are allowed and forbidden under the conservation of strangeness, baryon number, isospin and conservation of charge?

(i) $\pi^{+}+n\rightarrow\overline{k}^{0}+\Sigma^{+}$ (ii) $\pi^{-}+p\rightarrow\pi^{0}+\lambda^{0}$

(2.5+2.5)

$$m\left({}^{247}Bk\right)=247.070300\,u \quad m\left({}^{243}Am\right)=243.061375\,u \quad m\left({}^{251}Cf\right)=251.079580\,u$$
$$m\left({}^{247}Cm\right)=247.070347\,u \quad m_{\alpha}=4.00150\,u \quad m_{p}=1.00727\,u \quad m_{d}=2.01355\,u$$