St. Philomena's College (Autonomous), Mysore

Question Bank

Programme: M. Sc. Physics

III Semester

Course Title: NUCLEAR AND PARTICLE PHYSICS

Course Type: Hard Core

Q.P Code: 58202

Q. No.	Questions	Marks
1.	Give an account of nuclear spin.	3
2.	Write a short note on electric quadrupole moment of the nucleus.	3
3.	Define Isospin and give its importance.	3
4.	Write a note on pair production, with reference to interaction of gamma rays with matter.	3
5.	Define range and stopping power.	3
6.	Discuss the role of moderators in nuclear reactors.	3
7.	What are reflectors? Give their significance.	3
8.	Write a short note on quarks.	3
9.	Explain the need for strangeness quantum number.	3
10.	Discuss the classification of bosons.	3
11.	What are breeder reactors? Explain with examples.	4
12.	Explain nuclear isomerism with example.	4
13.	Explain internal and external Bremhstralung radiations.	4
14.	Calculate the energy released during the symmetric fission of ^{236}U.	4
15.	Give the basic assumptions of nuclear shell model.	4
16.	Explain how the ground state spin and parity for a nucleus in ground state is determined using the shell model.	4
17.	Explain photodisintegration process.	4
18.	Find the most stable isobar of A=25 using Semi empirical mass formula.	4
19.	Prove that nuclear density is independent of its mass.	4
20.	Explain Gellmann-Nishijima scheme.	4
21.	What is $\tau - \theta$ puzzle? Explain how it was resolved.	4
22.	Discuss the role of electric quadrupole moment in predicting the effective shape of the nucleus.	6

23.	Discuss the Mössbauer effect. List the necessary conditions for Mössbauer effect to occur.	6
24.	Discuss the Coulomb correction to the momentum distribution of beta particles in allowed beta decay.	6
25.	Explain the role of neutrino hypothesis in understanding the beta ray spectrum.	6
26.	Explain nuclear isomerism with example.	6
27.	Explain the classification of beta decay based on Comparative half life values.	6
28.	Discuss the conditions for controlled chain reaction and define the multiplication factor.	6
29.	Write a note on Bremsstrahlung radiation.	6
30.	Explain the properties of pi mesons.	6
31.	Explain the CP Violation in Kaon decay.	6
32.	Explain the molecular beam experiment to determine nuclear magnetic moment.	8
33.	Explain how the mesic X-ray method is used to estimate the nuclear radius parameter.	8
34.	Obtain the general expression for the Q value of the nuclear reactionX(x,y)Y.	8
35.	Analyze the role of spin orbit interaction in obtaining all the magic numbers using the shell model.	8
36.	With necessary details explain the fermi gas model of the nucleus.	8
37.	What is the evidence of shell structure in nuclei? Explain the main assumptions of the nuclear shell model.	8
38.	Describe the important features of beta ray spectrum emitted by radioactive nuclides. Explain how neutrino hypothesis explains the the process of beta decay.	8
39.	Explain the role of neutrino hypothesis in understanding the beta ray spectrum. What is Kurie plot.	8
40.	Define linear and mass attenuation coefficients and obtain an expression for the same.	8
41.	Analyze the role of reflectors and moderators in a nuclear reactor.	8
42.	With supporting experimental evidence, explain the exchange character of nuclear force.	8
43.	Explain the spin dependence and charge symmetric properties of nuclear of nuclear force.	8
44.	What are mirror nuclei? Explain how the Coulomb energy difference between mirror nuclei can be used to determine the nuclear radius parameter.	9
45.	Discuss the electron scattering experiment to measure the nuclear charge radius.	9
46.	Illustrate the molecular beam experiment to determine nuclear magnetic moment.	9
47.	Discuss various processes that take place when gamma rays interact with matter.	9

48.	Discuss the general features of nuclear forces based on the experimental evidences.	9
49.	Explain the spin dependence and tensor character of nuclear of nuclear force.	9
50.	Discuss in detail the classification of particles based on their spin.	9
51.	Outline the elementary ideas of standard model.	9
52.	What are strange particles? Explain the strangeness quantum number with examples.	9
53.	Obtain an expression for the magnetic dipole moment of odd A nuclei on the basis of single particle model.	10
54.	Obtain an expression for the magnetic dipole moment of odd A nuclei on the basis of single particle model.	10
55.	Prove that only lower magic numbers can be generated at shell closure using shell model theory with infinite square well potential.	10
56.	Derive an expression for the threshold energy of the endoergic nuclear reaction of the form X(x,y)Y.	10
57.	Explain the stability of isobars on the basis of liquid drop model.	10
58.	Discuss the basic assumption of liquid drop model of nucleus. Explain how this model is used to estimate semi empirical mass formula.	10
59.	Explain the internal conversion process and Auger effect. Obtain an expression for the conversion coefficient.	10
60.	Obtain an expression for the critical volume of a homogeneous spherical reactor using the neutron diffusion equation.	10
61.	Describe how a NaI(Tl) Scintillation detector is used for gamma ray spectroscopy.	10
62.	What are nuclear forces? With necessary details explain the spin dependence and charge independence character of nuclear forces.	10
63.	Explain the classification of fundamental forces. Give their salient features comparing and contrasting their basic properties.	10
64.	Explain the octet symmetry of baryons and mesons using weight diagram.	10
65.	Outline the Fermi's theory to explain the continuous energy spectrum in beta decay.	12
66.	Obtain the classical formula for energy loss of heavy charged particle through matter and then introduce relativistic corrections to obtain Bethe- Bloch formula.	12
67.	Discuss the Yukawa's theory of nuclear force.	12
68.	Discuss the conservation laws of elementary particles with examples.	12

Model Problems

69.	Compute the amount of energy released in fission of 1kg ^{235}U.	4
70.	Calculate the nuclear radius, given the difference in Coulomb energies between the mirror nuclei pair (^{29}Si, ^{29}P) is 4.96MeV	4

71. Predict the spin & parity of ^{17}O and ^{13}C using shell model. 4

72. A reactor is developing energy of the rate of $32x10^6$ watt. How many atoms of ^{235}U undergo fission per second. Assume that average energy released per fission is 200 MeV. 4

73. Give the quark combination of P and N. 4

74. Calculate the strangeness of Ω^- hyperon. 4

75. Calculate the Isospin of π mesons 4

MODEL QUESTION PAPER

Q.P Code: 14MSPCH301

St. Philomena's College (Autonomous) Mysore
III Semester M.Sc. - C3 – Final Examination, October 2017
Subject: PHYSICS
Title: NUCLEAR AND PARTICLE PHYSICS (HC)

Time: 3 Hours **Max Marks: 70**

Instructions: ***Answer one full question each from Section – A, Section – B and Section C and any four out of six questions from Section – D.***

PART – A

1. a. What do you understand by the terms distribution of nuclear charge and distribution of nuclear matter? Discuss the method of determining nuclear radius by electron scattering. **12**

   b. Write a note on electric quadrupole moment of a nucleus. **06**

OR

2. a. Discuss the role of spin orbit coupling in obtaining all magic numbers from the shell model. **12**

   b. Obtain an expression for Q-value of an endoergic reaction. **06**

PART – B

3. a. What are *ft* values? Based on these, explain the classification of beta transitions. **08**

   b. Write a note on Fermi – Kurie plot. **05**

   c. Write a note on Mossbauer effect. **05**

OR

4. a. Obtain an expression for the energy loss $\left(\frac{dT}{dx}\right)$ by ionization of matter, due to proton like charged particle. **09**

   b. Explain the gamma spectrum obtained using a NaI (Tl) scintillation gamma ray spectrometer. **09**

PTO

PART – C

5. a. Discuss the Yukawa theory of Nuclear forces. Explain the implication of the finite mass of the exchange particle on the internucleon forces. 12

   b. Describe the various properties of π-mesons, including their decay modes. 06

OR

6. a. Discuss the Gellmann – Nishijima scheme for elementary particles. 10

   b. Explain with suitable diagrams eight fold symmetry for baryons and mesons. 08

PART – D

Answer any FOUR of the following: 4x4=16

7. Consider the mirror nuclei $^{15}_{7}N$ and $^{15}_{8}O$, in which $^{15}_{8}O$ nucleus decays with e^+ emission carrying maximum energy of 1.68 MeV. Calculate the nuclear radius.

8. Calculate the Fermi energy for protons and neutrons in the nucleus $^{25}_{12}Mg$. (Given M = 0.057 amu)

9. In an absorption experiment with 1.14 MeV gamma radiation from ^{65}Zn it is found that 25 *cm* of *Al* reduces the beam intensity by 2%. Calculate the half thickness and the mass attenuation coefficient of *Al*. (Given: density of *Al* is 2700 kg/m^3).

10. A reactor producing energy at the rate of 32×10^6 Watts. Calculate how many atoms of ^{235}U undergo fission per second. Assume energy released per fission is 200 MeV.

11. Give the Quark combination of p, p^-, Σ^+ and λ^o.

12. Give an account of standard model of particle physics.

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