Question Bank

M.Sc. - PHYSICS

Course Code: MSCPH-06

Nuclear Physics and Analytical Techniques

Very Short Answer Type Questions

Q.1 What are quarks? Name the different flavours of quarks.

Q.2 Distinguish between leptons and hadrons.

Q.3 The binding energy per nucleon is low at low mass numbers and high mass numbers. Explain.

Q.4 Explain the ground state of deuteron. Plot the wave function for the deuteron ground state taken as an S-state.

Q.5 Express the Gell-mann-Nishijima formula.

Q.6 What are isomeric transitions?

Q.7 Explain Q value of nuclear reaction.

Q.8 Give the selection rule for forbidden decays.

Q.9 What are power reactors?

Q.10 What are magic numbers?.

Q.11 What are singly and doubly magic nuclei. List magic numbers below 100.

Q.12 What are block equations?

Q.13 What happens to the rotational constant of V = 1 state in comparison to V = 0 state if vibration rotation interaction takes place ?

Q.14 Define nuclear quadrupole moment.

Q.15 How does π meson account for the charge independence of nuclear forces ?

Q.16 What is the Q-value of a nuclear reaction ?

Q.17 Write down the simple Breit-Wigner one level formula for the cross-section of neutron reaction in nuclei.

Q.18 What are stripping and pick up reactions ?

Q.19 Describe the phenomenon of internal conversion.

Q.20 What are quarks ?

Q.21 Define Isospin Associated with elementary particles.

Q.22 Write down Bethe formula for stopping power of charged particles moving through the matter.

Q.23 What is the Gammow's theory of α decay?

Q.24 Explain the advantage of Bainbridge and Jordon mass spectroscopy.

Q.25 What is a straggling?

Q.26 Define p-p scattering at low energy.

Q.27 Calculate parity for ${}_{16}S^{33}$.

Q.28 What are ortho and para hydrogen molecules.

Q.29 What are Measons.

Q.30 Write down Semi Empirical mass Formula.

Short Answer Type Questions

Q.1 The ground state of 55Cs137 7/2+ decays with a half life 33 years,92% by emission to an excited state of 56Ba137(which in turn decays by emission with half life 2.6 minutes to the ground state Ba137)and 8%by emission directly the ground state.Following quantities were measured .

(K.E)max(92%)=0.51MeV (K.E) max(8%)=1.17MeV

What is the degree of forbiddenness of each transition?

Q.2 How many and particles are emitted when 92U238decay to Lead (82 Pb206).

Q.3 7Li (Z=3) and 7 Be(Z=4) have the atomic masses 7.016005 and7.016929u. Which of then shows activity and of what type? Calculate Q for it.

Q.4 Find the energy release of two 1H2 nuclei can fuse together to form 2He4 nucleus. The binding energy per nucleon of H2 and He4 is 1.1Mev and 7.0 respectively.

Q.5 Show that nuclear density of 1H1 is about 10^{14} times greater than atomic density assume the atom have the radius of the first Bohr model.

Q.6 A reactor is developing energy at the rate of 1500KW.How many atoms of U235 undergo fission per second? How many Kg of U235 would be used in 1000 hours of operation assuming that on an average energy of 200MeV is released per fission

Q.7 Obtain solutions for Block equations for steady state conditions.

Q.8 Derive an expression for the separation between consecutive rotational lines in non-rigid rotator approximation.

Q.9 Write down the applications of rotational spectroscopy.

Q.10 Explain energy levels, selection rules treating vibrating diatomic molecule as anharmonic oscillator.

Q.11 Explain the multipole moments for point charges.

Q.12 How do you determine quadrapole moment of deuteron?

Q.13 What are the properties of nuclear forces?

Q.14 Explain in detail the inferences drawn from the experimental data of deuteron.

Q.15 Explain various types of nuclear reactions.

Q.16 Obtain an expression for Q-value of the nuclear reaction.

Q.17 Can you determine the shape of neutron-proton potential from the data at 10 MeV energy ? Explain.

Q.18 Explain in importance of the nuclear shell model.

Q.19 What are various interactions that exist among the elementary particles ?

Q.20 Explain charge conjugation and space inversion invariance.

Q.21 Outline the theory of neutron-proton scattering at energies below 10 Mev.

Q.22 State clearly the definition of nuclear quadrupole moment and discuss the ground state of the deuteron in the light of the fact that it has small but finite quadrupole moment.

Q.23 Give the properties of the π -meson.

Q.24 Define the Q-value of a nuclear reaction? Establish the Q-equation of a nuclear reaction and find its solution.

Q.25 Give the simple Breit-Wigner one level formula for the cross-section of neutron reaction in nuclei. Explan how the width of the resonance level can be obtained from this formula.

Q.26 Obtain an expression for reaction amplitude using Born approximation for stripping and pick-up reaction (also called Butler theory).

Q.27. Give a brief account of Fermi's theory of β -decay and show how it was necessary to postulate the existence of neutrino. What is Kurie plot

Q.28 Describe the phenomenon of internal conversion. Obtain an expression for internal conversion coefficient for K-shell conversion in parity favoured transition.

Q.29 Write a detailed note on the classification of elementary particles. Q.30. Build up the structure of Mesons on quark model.

Q.30 Explain the structure of the ortho and para hydrogen molecules.

Long Answer Type Questions

Q.1 Describe Fermi theory of decay. Calculate the energy release in decay process.

Q.2 Derive an expression for scattering and reaction cross sections.

Q.3 Describe the types of nuclear fission reactors.

Q.4 Explain p-p scattering. Experimentally the study of p-p scattering is capable of much higher accuracy than n-p scattering. Why? What are the similarities of n-n and p-p forces?

Q.5 Write notes on

(a) Conservations laws among elementary particles.

(b) PQR branches in IR spectrum.

Q.6 Give the main assumptions of liquid drop model of the nucleus. Obtain the expression for the binding energy of a nucleus based on liquid drop model. State the semi-empirical formula of Weizacker.

Q.7 Describe quark model of elementary particles.

Q.8 Explain electric quadrupole moment for an ellipsoidal charge distribution.

Q.9 Write notes on

(a) Meson theory of nuclear forces.

(b) Semi-empirical mass formula.

Q.10 What is the evidence for shell structure of the nucleus? Sketching the main assumptions, explain the shell model of the nucleus.

Q.11 (a) State important features of Fermi theory of beta deacay and find the probability of emission per unit time for the electron.

(b) Explain the terms; Hypercharges, isospin and strangeness for elementary particles. State any two conservation laws for them.

Q.12 (a)Write a note on Shell model of the nucleus.

(b) Discuss electron scattering method to determine the size of the nucleus.