Yashwantrao Chavan College of Science Karad
Semester VI
Subject: Nuclear Physics
Question Bank

1. **Multiple Choice Questions**

Q1. The nucleus contains ....

1. protons and electrons
2. protons and neutrons
3. neutrons and electrons
4. neutrons and alpha particles

Q2. Isobars are the nuclides with same......

1. A-values, Z-values
2. A-values, N-values
3. Z-values, A-values
4. N-values, Z-values

Q3. Protons and neutrons have intrinsic spin equal to ....

1. $\hbar$
2. $2\hbar$
3. $\frac{\hbar}{2}$
4. 2π

Q4. Magnetic moment (μ_n) of neutron is

1. zero
2. $2.793\mu_N$
3. $-1.913\mu_B$
4. $1.913\mu_B$

Q5. Nuclear radius is proportional to

1. A
2. $A^{1/3}$
3. $A^{2/3}$
4. Z

Q6. Nuclear binding energy is

1. Mass defect $\times c^2$
2. $\frac{Massdefect}{c^2}$
3. Mass difference $\times c^2$
4. $\frac{Massdifference}{c^2}$

Q7. Binding Energy per nucleon is almost constants for .....

1. very light nuclides
2. all nuclides
3. very heavy nuclides
4. moderate mass nuclides

Q8. ......model is used to obtain semi-empirical mass formula.

1. liquid drop model
2. shell model
3. alpha-particle model
4. single particle model

Q9. Most stable nuclide is.....

1. $^{180}8$
2. $^{41}_{20}Ca$
3. $^{206}_{82}Pb$
4. $^{3}_{1}H$

Q10. One atomic mass unit (amu) is equal to

1. 931 g
2. 931 kg
3. 931 MeV
4. 931 eV

Q11. In particle accelerators, ... particles are accelerated.

1. positively charged
2. negatively charged
3. charged (+vely or -vely)
4. neutral

Q12. In resonance orbital accelerators, the frequency of revolution of ...... particles is

1. equal to the frequency of accelerating potential.
2. greater than the frequency of accelerating potential.
3. smaller than the frequency of accelerating potential.
4. not related to the frequency of accelerating potential.

Q13. Cyclotron is suitable to accelerate

1. neutrons
2. protons
3. electrons
4. positrons

Q14. Betatron is specially designed to accelerate

1. electrons
2. positrons
3. both electrons and positrons
4. protons

Q15. The period of revolution of a particle in a cyclotron is

1. independent of velocity of proton
2. independent of radius of orbit
3. independent of both velocity of particle and radius of orbit
4. proportional to the energy of the proton

Q16. The first orbital resonance accelerator built was..........

1. cyclotron
2. synchrocyclotron
3. betatron
4. proton synchrotron

Q17. .... accelerator provides maximum energy particles.

1. cyclotron
2. synchrocyclotron
3. betatron
4. proton synchrotron

Q18. Acceleration of...........is not feasible in cyclotron.

1. protons
2. electrons
3. deuterons
4. alpha particles

Q19. The phase stable orbit condition in synchrocyclotron is that the instantaneous P.D. across dees is....... and.

1. zero, about to become accelerating
2. zero, about to become decelerating
3. positive, very large

4. negative, very large

Q20. A frequency modulated supply is employed in

1. cyclotron
2. synchrocyclotron
3. betatron
4. electron-synchrotron

Q21. The magnetic pole-pieces are just above and below the donut tube in

1. cyclotron
2. betatron
3. synchrocyclotron
4. electron-synchrotron

Q22. The following detector uses the principle of ionization of gas by the energetic particle.

1. ionization chamber
2. GM-counter
3. cloud chamber
4. all the above

Q23. The following detector does not use the principle of ionization of gas by energetic ionizing particle.

1. semiconductor detector
2. GM-counter
3. ionization chamber
4. cloud chamber

Q24. The total number of ion-pairs produced by an ionizing particle depends upon its.....

1. mass
2. charge
3. initial energy
4. final energy

Q25. Gas amplification in ionization chamber is ....

1. equal to unity
2. less than unity
3. $\sim 10^3$
4. $\sim 10^8$

Q26. The gas amplification in GM-counter is

1. less than unity
2. equal to unity
3. $\sim 10^3$
4. $\sim 10^8$

Q27. Quenching gas in GM-tube is

1. air
2. Argon
3. Bromine vapour
4. Water vapour

Q28. Faithful counter is one which produces

1. one and only one pulse
2. continuous discharge
3. pulses one after another
4. none of the above

Q29. The electron multiplication is achieved in..........

1. GM-counter
2. photomultiplier tube
3. Scintillation detector

4. Cerenkov detector

Q30. Heart of a Scintillation counter is..........

1. MgO-coating
2. photomultiplier tube
3. phosphor
4. light guide

Q31. Cerenkov radiations are emitted by a particle moving with a .... the phase velocity of light in the same transparent medium.

1. half
2. less than
3. greater than
4. equal to

Q32. The sensitive period of a cloud chamber is when......

1. air in the chamber is clean i.e., has no dust particles
2. air in the chamber has no ions
3. air in the chamber contains saturated vapour
4. air in the chamber contains supersaturated vapour

Q33. .... force is not an interaction.

1. gravitational
2. electromagnetic
3. strong nuclear
4. centrifugal

Q34. .... force is an interaction.

1. centrifugal
2. frictional
3. electromagnetic
4. viscous

Q35. Rest mass of .... bosons is non-zero.

1. photon
2. electron
3. neutrino
4. graviton

Q36. .... interactions are very strong but have very short ranges.

1. gluon
2. electromagnetic
3. weak (W)
4. strong

Q37. .... interactions are very weak but have very large range.

1. strong
2. electromagnetic
3. weak
4. gravitational

Q38. .... are elementary particles which are not constituted of quarks.

1. Leptons
2. Baryons
3. Mesons
4. Nucleons

Q39. .... are elementary particles composites of three up (u) and down (d) quarks.

1. Leptons
2. Baryons

3. Mesons
4. Nucleons

Q40. .... are composites of a quark (u or d) and an antiquark ($\bar{u}$ or $\bar{d}$).

1. Nucleons
2. Leptons
3. Mesons
4. Hyperons

Q41. .... are composites of up (u), down (d), and strange (s) quarks.

1. Leptons
2. Baryons
3. Pions
4. Hyperons

Q42. Elementary particles have spin half and positive parity.

1. Baryons
2. Pions
3. Kaons
4. Photons

Q43. Elementary particles with zero spin and negative parity are called.....

1. Baryons
2. Pions
3. Kaons
4. both (b) and (c)

Q44. An abstract spin called isospin (T) is postulated to explain......

1. singlets
2. multiplets
3. bosons
4. fermions

Q45. Parity is not conserved in .... interactions.

1. electromagnetic
2. gravitational
3. weak
4. strong

Q46. Quarks have...... electronic charges.

1. zero
2. one unit of positive
3. one unit of negative
4. fractional

Q47. .... have not been observed physically.

1. Leptons
2. Quarks
3. Bosons
4. Hadrons

Short Answer Questions

Q1. What are nucleons? Explain their intrinsic properties.

Q2. What is the shape and size of the nucleus?

Q3. Discuss different methods used to measure nuclear radius.

Q4. What is binding energy of a nucleus? Explain.

Q5. What is the binding energy curve? Discuss its nature and applications.

Q6. Explain the liquid drop model for a nucleus.

Q7. Derive the semi-empirical mass formula.

Q8. Write a note on 'magic numbers'.

Q9. Discuss applications of the semi-empirical mass formula.

Q10. What is the need for particle accelerators?

Q11. Explain the theory, construction, and working of a cyclotron.

Q12. Obtain an expression for the maximum energy obtainable from a cyclotron. Discuss the limitations of a cyclotron.

Q13. Explain the phase-stable-orbit condition in detail.

Q14. Discuss the construction, working, and advantages of a synchrocyclotron.

Q15. Explain the principle of betatron.

Q16. Discuss the construction and working of betatron.

Q17. Obtain an expression for the maximum energy obtainable using a betatron.

Q18. What are synchrotrons?

Q19. Explain the principle of electron-synchrotron with special reference to two-step acceleration.

Q20. Provide the construction and working of an electron-synchrotron.

Q21. Discuss the principle of proton-synchrotron with a special reference to two-step acceleration.

Q22. Explain the construction and working of a proton-synchrotron.

Q23. Explain the principle of an ionization chamber.

Q24. Discuss the construction and working of an ionization chamber.

Q25. With the help of a block diagram, explain the GM-counter.

Q26. What do you mean by quenching of a GM-tube? Explain the self-quenching mechanism.

Q27. How is the working potential for a GM-tube decided?

Q28. What is the dead time of a GM-counter? How can a correction be applied to it?

Q29. Explain the construction and working of a photomultiplier tube.

Q30. What is a Scintillation detector?

Q31. Explain the construction and working of a Scintillation counter. What are the advantages of it over a GM-counter?

Q32. What do you mean by Cerenkov radiations? How can this principle be used to detect or count fast-moving charged particles?

Q33. Explain the theory, construction, and working of a semiconductor detector. Compare the maximum count rate of a semiconductor detector with other counters.

Q34. What are interactions and how are they mediated in different types of interactions?

Q35. Explain gravitational and electromagnetic interactions.

Q36. Discuss the weak and strong interactions.

Q37. Give the classification of the fundamental particles.

Q38. What are hadrons? Discuss their properties.

Q39. Write a short note on symmetries in elementary particles.

Q40. Discuss 'the basic conservation laws'.

Q41. Explain the invariance of space inversion and also discuss in which interactions it is violated.

Q42. Write a note on the quark-model.

Problems for Practice

P1. What is the distance of closest approach of a 2 MeV proton to a gold nucleus? ($Z_{gold} = 79$) [Ans.: 5.696×10^{-14} m]

P2. Chlorine-33 decays by positron emission with a maximum energy of 4.3 MeV. Calculate the radius of the nucleus. [Ans.: 4.68×10^{-15} m]

P3. Calculate the maximum energy obtainable for protons accelerated in a cyclotron having a maximum diameter of dees as 30 cm and the magnetic field induction used is 20,000 Gauss. [Ans.: 4.31 MeV]