

Paper: EX/SC/PHY/UG/DSE/TH/02/A1/2023(S)
B.Sc Physics Special Supplementary 2023
(3rd Year, 1st Semester)

Nuclear & Particle Physics

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Writing Time: Three hours

Full Marks: 75

Answer any five questions

(5X15)

1. (a) What do you mean by binding energy of a nucleus? Where from it comes? Draw the binding energy per nucleon versus mass no. curve and discuss the significance of its different portions. Approximately how much energy is required to separate all the nucleons of a nucleus of mass no. 100?
(b) Discuss about the different properties of nuclear force.

[2+2+5+2] + 4
2. What is stopping power? Find an expression for the stopping power of a heavy nucleus of charge "ze" moving with a velocity of "v" within a medium. A proton and a deuteron are moving with equal energy in a medium. Which one will have greater stopping power and why?

2+10+3
3. (a) Discuss the basic principle of acceleration in a Cyclotron. Show that maximum kinetic energy that can be imparted to a particle is directly proportional to the square of the radius of the dees for a constant applied magnetic field. What kind of problem is faced when the accelerating particle acquires relativistic velocity? How the problem can be solved?
(b) A Cyclotron uses a magnetic field of 1.4 Wb/m^2 to accelerate protons of mass $1.67 \times 10^{-27} \text{ Kg}$. How rapidly should the electric field between the dees be reversed?

[4+4+2+2]+3
4. (a) What do you mean by Q value of a nuclear reaction $X(a,b)Y$? Classify nuclear reactions in terms of Q value. Derive an expression of Q value in terms of kinetic energy of projectile and ejected particle.
(b) Define the threshold energy for a nuclear reaction and derive an expression in terms of Q value and other relevant parameters.

[2+3+6]+4
5. (a) What are leptons? Mention names of all members of lepton family with generations. Are all of them stable? Explain with example.

[Turn Over

(b) Why neutrinos are difficult to detect? Write down the interaction by which electron neutrinos were detected experimentally. Describe the experiment by which C. L. Cowan and F. Reines were confirmed about the detection of neutrino.

[2+3+2]+[1+1+6]

6. (a) What are strange particles? Discuss about their production and decay with example.
- (b) What are strangeness and hypercharge quantum number? Discuss about their conservation rules in different basic interactions.
- (c) Write down Gellmann Nishijima formula and explain each term.
- (d) How many fundamental forces are there in nature? Write their name and their corresponding force carrier particles.

[1+3]+[2+2]+3+4

7. (a) What is a Radiation Detector? What are different gas filled ionization based detectors?
- (b) Discuss the different region of operations from the curve-“Number of ion-pairs collected vs Applied voltage”
- (c) Explain the phenomenon of quenching in a GM counter.
- (d) Define dead time, recovery time and resolving time of a GM Counter?
- A GM Counter with a dead time of $300\mu\text{s}$ records 1600counts/min. What is the number of count loss per min?

3+6+3+3