

P. R. Thakur Govt. College

Department of Physics

B.Sc. Semester-V Internal Examination, 2024-25

Paper – **PHSADSE03T**

Nuclear and Particle Physics

Time: 1 Hour

Full Marks: 20

1. Answer any five questions from the following: 2×5=10

- (a) What is straggling of range of an α -particle?
- (b) Prove that electrons cannot exist in the nucleus.
- (c) What is the minimum kinetic energy required to probe a nucleus of diameter 10fm?
- (d) Write down the main assumptions of liquid drop model of the nucleus.
- (e) What is the evidence for the shell structure of the nuclei?
- (f) Calculate the mass number of the nucleus whose radius is 4.8×10^{-15} m.
Given $r_0 = 1.3$ fm
- (g) Explain the concept of strangeness and principle of associated production.
- (h) What are the spin-parity of ${}^{13}_6\text{C}$?

Department of Physics
P.R. Thakur Govt. College

2. Answer any two questions from the following: 5×2=10

- (a) Write down the Bethe-Weizäcker Semi-empirical mass formula of a nucleus, clearly mentioning the meaning of each term.
- (b) Discuss the working of a G.M. counter? What do you mean by quenching of a G.M. counter? 3+2
- (c) What is meant by SU(3) symmetry of strong interaction? Write CPT conservation law. 3+2
- (d) Define Q-value of a nuclear reaction. Derive an expression for the Q-value of the reaction $X(a,b)Y$ in terms of kinetic energies of the incident and product particles and masses of the various particles and nuclei. Assume the target nucleus to be at rest in the laboratory. 1+4

P. R. Thakur Govt. College

Department of Physics

B.Sc. Semester-V Internal Examination, 2023-24

Paper – PHSADSE03T

Nuclear and Particle Physics

Time: 1 Hour

Full Marks: 20

1. Answer any five questions from the following:

2×5=10

- Department of Physics
P.R. Thakur Govt. College
- (a) What does non-zero quadrupole moment of a nucleus signify?
 - (b) Which nuclei would you expect to be more stable – Li^7 or Li^8 ? Justify your answer.
 - (c) What is mirror nuclei? Give example.
 - (d) Explain why electrons cannot exist in the nucleus.
 - (e) Write down the main assumptions of liquid drop model of the nucleus.
 - (f) Why are even-even nuclei most stable?
 - (g) What is meant by range of an α -particle? On what factors does it depend?
 - (h) Mention two differences between direct nuclear reaction and compound nuclear reaction.

2. Answer any two questions from the following:

5×2=10

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- (a) What do you mean by binding energy of a nucleus? Show graphically the variation of average binding energy per nucleon with mass number and hence discuss the stability of a nucleus. 2+3
 - (b) Write down the Bethe-Weizäcker Semi-empirical mass formula.
Calculate the atomic number of the most stable nucleus for a given mass number A from Bethe-Weizäcker Semi-empirical mass formula. 2+3
 - (c) Why spin-orbit coupling is necessary in Shell model to reproduce magic numbers? What are the spin-parity of C^{13} in its ground state? 3+2
 - (d) Define Q -value of a nuclear reaction. Derive an expression for the Q -value of the reaction $X(a,b)Y$ in terms of kinetic energies of the incident and product particles and masses of the various particles and nuclei. Assume the target nucleus to be at rest in the laboratory. 1+4

P. R. Thakur Govt. College

Department of Physics

B.Sc. Semester-V Internal Examination, 2022

Paper – PHSADSE03T

Nuclear and Particle Physics

Time: 1 Hour

Full Marks: 20

1. Answer any five questions from the following: 2×5=10

- (a) What do you mean by mirror nuclei? Give two examples.
- (b) Write the characteristics of nuclear forces.
- (c) What do you mean by Q-value of a nuclear reaction?
- (d) Show that electrons cannot exist within the nucleus.
- (e) Write down the main assumptions of liquid drop model of the nucleus.
- (f) Calculate the ratio of Nuclear magneton to Bohr magneton.
- (g) Which nuclei would you expect to be more stable – ${}^7_3\text{Li}$ or ${}^8_3\text{Li}$? Justify your answer.
- (h) Using the extreme single particle shell model determine the ground state spin-parity of O^{17} .

2. Answer any two questions from the following: 5×2=10

- (a) Discuss with a neat diagram the nature of variation of binding energy per nucleon for different nuclei plotted against the corresponding mass number. Determine the relation between binding fraction and packing fraction. 3+2
- (b) Write down the main assumptions of liquid drop model of the nucleus. Write down the Bethe-Weizsäcker semi-empirical mass formula for a nucleus of atomic number Z and mass number A and explain briefly the different terms in the formula. 2+3
- (c) Explain how liquid drop model can explain the phenomenon of nuclear fission. What is meant by range of an α -particle? On what factors does it depend? 2+2+1
- (d) Draw and discuss the energy spectrum curve of β -decay. What is 'end point energy'? The half life of a radioactive substance is 2.5 days. Calculate the percentage of original material left after 7.5 days. 2+1+2

P. R. Thakur Govt. College

Department of Physics

B.Sc. Semester-V Internal Examination, 2021

Paper – **PHSADSE03T**

Nuclear and Particle Physics

Time: 1 Hour

Full Marks: 20

1. Answer any five questions from the following: 2×5=10

- (a) Prove that electrons cannot exist in the nucleus.
- (b) Write down the main assumptions of liquid drop model of the nucleus.
- (c) What is the evidence for the shell structure of the nuclei?
- (d) Why are even-even nuclei most stable? Department of Physics
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- (e) Derive a relation between half life and radioactive constant.
- (f) One mg of radioactive material with half life of 1600 years is kept for 2000 years. Calculate the mass which would have decayed by this time.
- (g) What is meant by range of an α -particle? On what factors does it depend?
- (h) Explain the concept of strangeness and principle of associated production.

2. Answer any two questions from the following: 5×2=10

- (a) Calculate the atomic number of the most stable nucleus for a given mass number A from Bethe-Weizäcker Semi-empirical mass formula. What is the basic point of difference between the liquid drop model and shell model of the nucleus? Department of Physics
P.R. Thakur Govt. College 3+2
- (b) Discuss the theory of successive disintegration of radioactive substance and obtain the conditions for transient and secular equilibrium.
- (c) Define Q -value of a nuclear reaction. Derive an expression for the Q -value of the reaction $X(a,b)Y$ in terms of kinetic energies of the incident and product particles and masses of the various particles and nuclei. Assume the target nucleus to be at rest in the laboratory. 1+4
- (d) What do you mean by colour of a quark? What is its importance? Which quarks make up the Λ^0 , Σ^+ , and Ω^- hyperons? 1+1+3