(b) Write down the quark compositions of $\pi^+$, p, $K^0$ and $\Delta^+$. (4)

(c) Classify the fundamental forces based on strengths, range and reaction rate. (5)

7. Write short note on the following :

(a) Photoelectric Effect (5)

(b) Geiger Nuttall law. (5)

(c) Fermi gas model. (5)



Roll No. ..... Total Pages : 4

**321603**

**May - 2026**

**B.Sc. (Physics) VIth SEMESTER**

**Nuclear and Particle Physics (BPH24-603T)**

Time : 3 Hours] [Max. Marks : 75

*Instructions :*

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

**PART-A**

1. (a) By what process $_8O^{15}$ likely to decay? Write the reaction. (1.5)

(b) What is electric quadrupole moment? (1.5)

(c) Why visible light cannot be used to detect Compton effect? (1.5)

(d) Write quark structure of nucleons? (1.5)

(e) Why $_6C^{14}$ is radioactive and $_6C^{12}$ is not? (1.5)

(f) What are magic numbers? What is their significance? (1.5)

(g) Explain how electrons and heavy ions differ in their interactions with matter. (1.5)

(h) What is straggling? Discuss the factors responsible for it? (1.5)

(i) Explain the concept of isospin. (1.5)

(j) The half-life $T_{1/2}$ of radon is 3.8 days. After how many days will 1/100$^{th}$ of a radon sample be left behind? (1.5)

## PART-B

2. (a) Give the reason for non-existence of electron in the nucleus. What do you understand by nuclear size. Explain the relation between nuclear mass with nuclear size. Show how binding energy changes with mass number. (8)

(b) Calculate binding energy of deuterium Given : $m_H$ = 1.007825u, $m_n$ = 1.008665u and $m_D$ = 2.014102u. (3)

(c) What is nuclear magneton? Determine the radius of $^{208}Pb$. (4)

3. (a) Discuss basic assumptions of liquid drop model of the nucleus. Discuss how this model can be used to estimate the semi-empirical mass formula. (10)



(b) State the relevant rules regarding shell model predictions about the ground state spin-parities of nuclei. Predict the ground state spin-parities of the following nuclei : $_2He^3$, $_3Li^7$, $_6C^{12}$ and $_{12}Mg^{25}$. (5)

4. (a) Explain $\alpha$-decay and discuss Gamow's theory of $\alpha$-decay. (10)

(b) Explain qualitatively the phenomenon of gamma decay in nuclei. (5)

5. (a) A charge particle having charge Ze, mass M and kinetic energy E is passing through a certain medium having n electrons per unit volume. If the motion of the particle is along x-direction, derive an expression for the rate of loss of energy. State the Bethe-Bloch modifications and write the Bethe-Bloch formula. (10)

(b) What is meant by stopping power and on what factors does it depend? (5)

6. (a) Indicate the interactions responsible for the following reactions :

1. $p + p \rightarrow p + n + \pi^+$
2. $\Lambda^0 \rightarrow n^+ \pi^-$
3. $\pi^0 \rightarrow \gamma + \gamma$
4. $\Omega^- \rightarrow \Lambda^0 + K^-$

(6)