

U.G. 6th Semester Examination - 2020**PHYSICS****Course Code : BPHSDSHT4****Course Title : Nuclear and Particle Physics**

Full Marks : 40

Time : 2 Hours

*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.*

1. Answer any **ten** questions: $1 \times 10 = 10$
- What is mirror nuclei? Give an example.
 - Explain the nuclear magnetic moment.
 - Why stable nuclei have more neutrons than protons?
 - What do you mean by nuclear isomerism? Give an example.
 - Write down the relation between strangeness quantum number (S) and the electric charge of a elementary particle (Q).

- What is anti-particle? Give an example of a anti-particle which exist in nature.
- Mention two important applications of radioactivity.
- What is Cherenkov radiation?
- Explain the Fermi gas model.
- Predict:
 - the ground state spin
 - parity of ${}_{13}^{27}\text{Al}$
- What is nuclear transmutation?
- Define Q-value of a nuclear reaction.
- Define Baryons and Mesons with an example each.
- ${}_{94}^{236}\text{Pu}$ will spontaneously decay by α -emission. Find the Q_{α} .
 [Given $M_{\text{Pu}} = 236.046\text{u}$; $M_{\text{U}} = 232.037\text{u}$; $M_{\text{He}} = 4.0020\text{u}$]

$${}_{94}^{236}\text{Pu} \rightarrow {}_{92}^{232}\text{U} + {}_2^4\text{He} + Q_{\alpha}$$
- What do you mean by internal conversion?

[Turn Over]

2. Answer any **five** questions: $2 \times 5 = 10$

a) Calculate the binding energy of an α -particle (${}^4_2\text{He}$).

[Given $M_p = 1.007276\text{u}$; $M_n = 1.008665\text{u}$; $M_{\text{He}} = 4.002603\text{u}$]

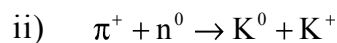
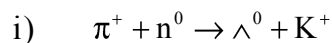
b) Neutron is charge neutral particle. Does it have magnetic moment? If yes, explain it.

c) A radioactive source emits α and β particles with 1600 years and 400 years as respective half-life. After what time would the one-fourth of the material remain unchanged?

d) Write down the differences between the Shell model and Liquid drop model.

e) Write down the quark content of the following particles Λ , Σ^+ , π^+ and K^- .

f) Which of the reactions are possible?



g) Explain clearly the meaning of *isotopic spin* and *strangeness*.

h) What is Geiger-Nuttall law? What is the importance of this law?

Answer any **two** questions: $5 \times 2 = 10$

3. a) What is Geiger law? Derive the Geiger law. $1+2$

b) ${}^{212}\text{Po}$ emits an α -particle of 8.776 MeV energy. Calculate the disintegration energy that correspond to it. 2

4. Obtain Bethe-Wiezsacker semi-empirical mass formula. Clearly explaining the significances of the term involved. 5

5. a) Define the threshold energy of endoergic reaction and derive the expression for threshold energy. $1+2$

b) Calculate the threshold energy for the nuclear reaction ${}^{14}\text{N}(n, \alpha){}^{11}\text{B}$ in MeV.

[Given: $M_N = 14.007550\text{u}$; $M_n = 1.008987\text{u}$; $M_B = 11.012811\text{u}$; $M_{\text{He}} = 4.003879\text{u}$] 2

Answer any **one** question: $10 \times 1 = 10$

6. a) Describe in detail the working principle of a GM-counter. What is dead time and recovery time? How is quenching achieved in a GM-counter? $2+1+2$

- b) Explain the principle and operation of a scintillation counter. $2\frac{1}{2}$
- c) What are the advantages of semiconductor detector over ionisation chamber? $2\frac{1}{2}$
7. a) What are the three forms of β -decay? Find out the condition of their occurrence. $2+3$
- b) Explain the Kurie plot. Write down the selection rule for allowed β -transition. $2+1$
- c) What are the basic properties of neutrino? 2
8. a) Calculate the mass defect of the $^{108}_{47}\text{Ag}$ nucleus.
- b) Consider a nuclear reaction in which an incident particle of mass m_i and kinetic energy t_i collides with a target particle of mass m_t at rest. After the reaction, an emitted particle of mass m_e and kinetic energy t_e leaves the residual nucleus of mass m_r and kinetic energy t_r . Find out the Q value of this reaction in terms of scattering angle in the nonrelativistic approximation.

- c) Out of the two particles, which one is a lepton: ν_μ, k_0 ? $3+6+1$
