

2023
B.Sc. (Honours)
B.Sc. Fifth Semester End Examination - 2023
PHYSICS
PAPER - DSE-2T

Full Marks : 60

Time : 3 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.
Illustrate the answers wherever necessary.

Group - A

1. Answer any five questions : 2×10=20
- (a) How momentum of nucleon in nucleus varies with mass number? 2
- (b) Find spin and parity for ground state of ${}_{18}^{41}\text{Ar}$. 2
- (c) What do you mean by differential cross-section? and its significance. 2
- (d) The half-life of Ux_1 is 24.1 days. How many days, after Ux_1 has been isolated, will it take for 90% of it to change to Ux_2 ? 2

(Turn Over)

(2)

- (e) What is specific ionisation of α -particle? 2
- (f) What do you mean by 'Helicity'? Write down its significance. 2
- (g) What is the working of Di-anode in photomultiplier tube? 2
- (h) What is iso-spin? 2
- (i) What is Dead time and delay time of GM counter. 2
- (j) Write down Geiger-Nuttall law. 2
- (k) Calculate the magnetic moment of deuteron. 2
- (l) What are magic numbers? 2
- (m) What do you mean by strangeness number and hypercharge? 2
- (n) Compare a fixed frequency cyclotron with a betatron. 2
- (o) What are kaons? How are they produced? 2

Group - B

Answer any four questions. 5×4=20

2. (a) State the characteristics of nuclear force. 2
- (b) ${}^4_2\text{He}$ nucleus has no magnetic moment. Explain. 1
- (c) Determine the radii of a ${}^{16}\text{O}$ nucleus and a ${}^{208}\text{Pb}$ nucleus 1

(3)

- being given that $r_0=1.4$ fm. 2
3. (a) Describe the construction and working principle of betatron. 2+1
- (b) Discuss factors that limit the maximum energy. 2
4. (a) What are quarks? 2
- (b) Are the following reactions allowed? Give reasons in support your answer. 3
- (i) $\pi^+ + p^+ \rightarrow \pi^0 + n$ (ii) $k^+ + \pi^+ \rightarrow p^+ + p^+$
5. (a) Explain the operation of semi conductor detector. 2
- (b) The atomic masses of ${}^{226}_{88}\text{Ra}$ and ${}^{222}_{86}\text{Rn}$ are 226.0254 u and 222.0175 u respectively. Find the kinetic energy of α particle. [$m({}^4_2\text{He}) = 4.0026$ u] 3+2
6. (a) How does gamma ray interact with matter? 2
- (b) Determine the intrinsic parity of π^- in following reaction. 2
- $\pi^- + d \rightarrow n + n$
7. (a) What is parity? How parity conservation is connected to conservation laws of elementary particles. 2
- (b) Explain 'internal conversion' process in gamma ray spectrum. 3+2

(4)

Group - C

Answer any two questions :

10×2=20

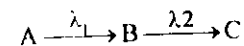
8. (a) On the basis of liquid drop model give a simple derivation of Weizsacker semi-empirical mass formula giving arguments for each term. 5
- (b) What are the important conclusions drawn from its formula. 3
- (c) Assuming nuclear shell index to be correct, what would be the spin and parity of the ground state of ${}_{78}^{157}\text{N}$? 3
9. (a) Define Q-value of nuclear reaction. Mention various conservation laws in nuclear reaction. 3
- (b) A nucleus of mass M absorbs a photon energy $h\nu$. Show that the energy of excitation of the nucleus is given by
- $$Mc^2 \left[\left(1 + \frac{2h\nu}{Mc^2} \right) - 1 \right]$$
- (c) Describe the compound nucleus theory of nuclear reactions. 2

(5)

10. (a) Show that, in Rutherford scattering process the scattering cross-section for scattering angle θ is proportional to $\frac{1}{\sin^4(\theta/2)}$. 5

- (b) Draw and explain the construction of GM counter. What is external and internal quenching in GM counter? 3+2

11. (a) Radioactive nucleus A decays to another radioactive nucleus B which in turn decays to a stable nucleus C.



If at $t=0$, the number of nuclei A and B were N_0 and zero and λ_1 and λ_2 are disintegration constants.

Then show that at t_0 time, number of B nuclei

$$N_B = \frac{N_0 \lambda_1}{\lambda_2 - \lambda_1} (e^{-\lambda_1 t_0} - e^{-\lambda_2 t_0})$$

and N_B is maximum at time, $t_{\max} = \frac{\ln \left(\frac{\lambda_2}{\lambda_1} \right)}{\lambda_2 - \lambda_1}$

Also discuss the condition of transient and secular equilibrium. 2+1+4

- (b) Explain colour quantum number in the view of flavour symmetry in elementary particle synthesis. 3