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 moentum of nucleon in nucleus varies with mass number? 2

(b) Find spin and parity for ground state of $^{41}_{18}Ar$. 2

(c) What do you mean by differential cross-section? and it's 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)

(e) What is specific ionisation of α-particle?

(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?

(n) Compare a fixed frequency cyclotron with a betaron. 2

(o) What are kaons? How are they produced?

Group - B

Answer any four questions. **5×4=20**

2. (a) State the characteristics of nuclear force. 2

(b) $_2He^4$ nucleus has no magnetic moment. Explain. 1

(c) Determine the raii of a ^{16}O nucleus and a ^{208}Pb nucleus

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 concuctor detector.

(b) The atomic masses of $^{226}_{88}Ra$ and $^{222}_{86}Rn$ are 226.0254 u and 222.0175 u respectively. Find the kinetic energy of α particle. [m($^4_2$He) = 4.0026 u] 3+2

6. (a) How does gamma ray interact with matter?

(b) Determine the intrinsic partity of π^- in following reaction.

$\pi^- + d \rightarrow n + n$

7. (a) What is parity? How parity conservation is connected to conservation laws of elementary particles.

(b) Explain 'internal conversion' process in gamma ray spectrum. 3+2

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 $_{7}N^{15}$? 2

9. (a) Defind 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

10. (a) Show that, in Rutherford scattering process the scattering cross-section for scattering angle 0 is proportional to $\frac{1}{\sin^4\left(\theta/2\right)}$. 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 is turn decays to a statble nucleus C.

$$A \xrightarrow{\lambda_1} B \xrightarrow{\lambda 2} C$$

    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

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

    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