



RAN - 2103000205021003

**RAN-2103000205021003****T. Y. B. Sc. (Sem. - V) Examination March - 2023****Physics : Paper - VIII (PH - 508)****Atomic and Nuclear Physics****Time: 2 Hours ]****[ Total Marks: 50****सूचना : / Instructions**

(1)

नीचे दृश्यावलोकन निशानीवाणी विगतो उत्तरवही पर अवश्य लभवी.  
Fill up strictly the details of signs on your answer book

Name of the Examination:

☛ T. Y. B. Sc. (Sem. - V)

Name of the Subject :

☛ Physics : Paper - VIII (PH - 508) Atomic and Nuclear Physics

Subject Code No.: 2103000205021003

Seat No.:

Student's Signature

- (2) Figures to the right indicate total marks carried by the question.  
(3) All symbols used have their usual meaning.  
(4) Students are allowed to use a non-programmable scientific calculator.

**Q. 1. Answer in brief:****[10]**

- (1) What are the possible values of principal quantum number ? What does it describe?
- (2) What are the possible values of magnetic quantum number  $m_l$  of an electron whose orbital quantum number is  $l = 4$ ?
- (3) Unit of the gyromagnetic ratio is \_\_\_\_\_.
- (4) What are the possible values of magnetic spin quantum number ( $m_s$ )?
- (5) Unit of Planck's constant  $h$  and unit of \_\_\_\_\_ are same.
- (6) Write any two similarities between liquid drop and nucleus.
- (7) Give two achievements of the shell model.
- (8) Why  $\alpha$  particles are deflected by electric and magnetic fields?
- (9) How are atomic number and atomic mass number change during  $\beta$  decay?
- (10) Why  $\beta$  decay is called isobaric transformation?

- Q. 2. (A) Answer any one in detail:** [07]
- (1) Explain how three quantum numbers  $n$ ,  $l$  and  $m_l$  are obtained as a natural consequence of solving Schrodinger's equation for hydrogen atom.
  - (2) Explain quantization of angular momentum direction. How the uncertainty principle prohibits the angular momentum vector from having a definite direction in space.
- (B) Answer any one:** [03]
- (1) Calculate electron angular momentum  $L$  for orbital quantum number  $l = 3$ .  
Take value of Planck's constant  $h = 6.625 \times 10^{-34} \text{ J-s}$
  - (2) Find the percentage difference between angular momentum  $L$  and the maximum value of  $L_z$  for an atomic electron in a  $p$ -state.
- Q. 3. (A) Answer any one in detail:** [07]
- (1) What is Zeeman effect? Explain splitting of spectral line in normal Zeeman effect.
  - (2) Explain in detail about radiative transitions.
- (B) Answer any one:** [03]
- (1) Zeeman components of a 500 nm spectral line are 0.0116 nm apart when the magnetic field is 1.00 T. Find the ratio  $e/m$  for the electron from these data.
  - (2) Calculate the value of Bohr magneton. Mass of electron is  $9.1 \times 10^{-31} \text{ kg}$ , charge of electron is  $1.6 \times 10^{-19} \text{ C}$  and Planck's constant  $h = 6.625 \times 10^{-34} \text{ J-s}$ .
- Q. 4. (A) Answer any one in detail:** [07]
- (1) Discuss the shell model of the nucleus.
  - (2) Derive the semiempirical mass formula of the nucleus.
- (B) Answer any one:** [03]
- (1) Calculate the contribution of Coulomb energy and surface energy terms of  ${}_{92}^{236}\text{U}$ . Proportionality constants for Coulomb energy term and surface energy terms are 0.7 MeV and 16.8 MeV respectively.
  - (2) Calculate the binding energy of an  $\alpha$ -particle in MeV. Mass of the  $\alpha$ -particle is 4.0028 amu, mass of proton and neutron are 1.00758 amu and 1.00897 amu. Take 1 amu = 931.5 MeV.

**Q. 5. (A) Answer any one in detail:**

**[07]**

- (1) What is the range of alpha particle? Explain Geiger-Nuttal law in detail.
- (2) Explain in detail about applications of radioactivity.

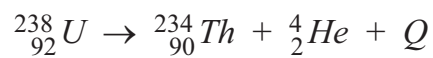
**(B) Answer any one:**

**[03]**

- (1) Rutherford bombarded 7.7 MeV  $\alpha$ -particles from  $Po^{214}$  on  ${}^{14}_7N$  to initiate the nuclear reaction  ${}^{14}_7N(\alpha, p){}^{17}_8O$ . Find the height of Coulomb barrier faced by  $\alpha$ -particles.

$$\epsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{N-m^2} \text{ and constant } R_0 = 1.2 \text{ fm.}$$

- (2) Find the energy released in the  $\alpha$ -decay of  ${}^{238}_{92}U$ :



Give :  $M({}^{238}_{92}U) = 238.050786 \text{ amu,}$

$$M({}^{234}_{90}Th) = 234.043583 \text{ amu}$$

$$M({}^4_2He) = 4.002603 \text{ amu}$$

$$1 \text{ amu} = 931.5 \text{ MeV}$$

---