Reg. No. | | | | | | | | | |

BSCPHC 357

Credit Based VI Semester B.Sc. Degree Examination, September 2022
(2020 – 21 and Earlier Batches)
PHYSICS (Paper – VII)
Nuclear Physics

Time : 3 Hours Max. Marks : 80

Instructions *: 1) Answer questions from* ***all*** *Units.*
2) Multiple choice questions must be answered in the ***first two*** *pages of the answer book.*
3) Scientific calculators are ***allowed****.*

PART – A

1. Answer the following questions by choosing the most appropriate answer. **(1×10=10)**

i) The heaviest stable nucleus is
a) $_{209}Bi$ b) $_{208}Pb$ c) $_{207}Pb$ d) $_{206}Pb$

ii) β particle is an electron of _____ origin.
a) Atomic b) Nuclear
c) Both of the above d) None of these

iii) Condition for secular equilibrium is
a) Half-life of parent is equal to that of daughter element
b) Half-life of parent is less than that of daughter element
c) Half-life of parent is slightly greater than that of daughter
d) Half-life of parent is very large compared to that of daughter

iv) Which of the following form the pair of mirror nuclei ?
a) $_6C^{11}$ and $_5B^{11}$ b) $_3Li^7$ and $_4Be^7$
c) $_1H^3$ and $_2He^3$ d) All of these

v) The nuclear quadrupole moment of nuclei containing magic number of nucleons is
a) Positive b) Negative
c) Zero d) None of these

P.T.O.

vi) If 5 gram of U-235 is completely destroyed in a reactor, the energy released would be

a) 45×10^3 J b) 15×10^{10} J c) 45×10^{17} J d) 60×10^{15} J

vii) Nuclear reactor at Kaiga is

a) Research reactor b) Fusion reactor

c) Breeder reactor d) Power reactor

viii) Neutrino belongs to the family called

a) Hadrons b) Leptons

c) Baryons d) Hyperons

ix) The maximum energy gained by the electron in a betatron is

a) B e r C b) B e r^2 C

c) B^2 e r C d) B e r C^2

x) Cosmic rays were discovered by

a) Thomson b) Curie c) Hess d) Millikan

2. Answer **any five** of the following : **(2×5=10)**

i) Give the empirical relation between range and velocity of an alpha particle.

ii) According to Pauli's theory how many types of neutrinos are there ? What is the difference between them ?

iii) Show that nuclear density is constant.

iv) Which has higher binding energy $_1H^3$ or $_2He^3$? Comment on the difference.

v) How are thermal neutrons produced ?

vi) Name the four basic interactions of the nature.

vii) Draw GM characteristics.

PART – B

Unit – I

3. a) State and explain Geiger-Nuttal law.

b) With elements A, B and C forming a radioactive series (C being stable), derive an expression for the number of atoms of B if at start B was not present in the sample. Hence derive the condition for secular equilibrium. **(4+6)**

OR

4. a) What is radioactive dating ? Explain radio carbon dating.

   b) Explain 3 types of Beta decay, using Paulis neutrino hypothesis. What are the condition for the emission of $\beta+$ and electron capture ? **(4+6)**

5. a) Radon the disintegration product of radium is in equilibrium with 1 gram of radium. Find the mass of radon. Half-life of Ra-226 = 1590 years, Rn-222 = 3.82 days. **5**

   OR

   b) 1 gram of radium is reduced by 2.1 mg in 5 years by alpha decay. Calculate the half-life period of radium. **5**

Unit – II

6. a) Explain how shell model accounts for the first 3 magic numbers.

   b) Derive α particles scattering formula assuming expression for impact parameter. Also mention the factors on which the number of α-particles scattered depend. **(4+6)**

   OR

7. a) Using Heisenberg's uncertainty principle estimate the rest mass of meson assuming the range of nuclear forces as 1.5 fm.

   b) What is a mass spectrograph ? Describe with theory Dumpster's mass spectrograph. Explain how isotopic abundances can be determined. **(4+6)**

8. a) In a Dumpster's mass spectrograph a 1000 V accelerating potential brings singly ionized Mg – 24 on the slit. Calculate the potential difference to bring singly ionized Mg – 25 on the slit, the magnetic field being kept constant. **5**

   OR

   b) In Rutherford α-ray scattering experiment, the flux of α-particles observed at 100 is 106 per minute. Calculate the flux of α-particles observed at (i) 90° (ii) 180°. **5**

Unit – III

9. a) Write a short note on fast breeder reactors.

   b) Explain nuclear fission with an example. Obtain the four factor formula for thermal reactors and discuss the condition for criticality. **(4+6)**

   OR

10. a) Give Rutherford's experiment on artificial transmutation.

    b) With a diagram explain working of a nuclear reactor. What is the difference between pressurised water reactor and boiling water reactor ? **(4+6)**

11. a) It is proposed to produce 100 MW of electrical power on an average in a nuclear reactor having 20% efficiency, using U-235. Calculate the amount of U-235 required per day for continuous operation. Given energy released per fission of U-235 is 200 MeV. **5**

    OR

    b) Show by mass-energy calculation whether the following reactions are endoergic or exoergic. 14N (α, p) 17 O. **5**

Unit – IV

12. a) Explain the working of a semiconductor detector.

    b) Explain the classification of fundamental particle with respect to mass, spin and interaction. **(4+6)**

    OR

13. a) Explain Van Allen radiation belts.

    b) With neat diagram explain the working of linear accelerator. **(4+6)**

14. a) A cyclotron accelerate protons to 4 MeV. To what energy will the cyclotron accelerate (a) alpha particles and (b) deuteron. **5**

    OR

    b) In a certain betatron the maximum magnetic field at orbit was 0.4 Weber/m^2, operating at 50 Hz with a stable orbit diameter of 1.524 m. Calculate the average energy gained per revolution and the final energy of the electrons. **5**
