Time: 3 Hours **Total Marks: 100**

N.B. : (1) **All** questions are **compulsory**.
(2) **Figures** to the **right** indicate **full** marks.
(3) Draw **neat** diagrams wherever **necessary**.
(5) Symbols have usual meaning unless otherwise stated.
(5) Use of **non-programmable** calculator is allowed.

Constants: Planck's constant (h) = 6.64 x 10^{-34} J-s;
Mass of an electron (m_e) = 9.10 x 10^{-31}Kg = 0.00055 amu
Charge on electron (e) = 1.60 x 10^{-19} C
Speed of light (c) = 3 x 10^{8} m/s
1 eV = 1.60 x 10^{-19} J
1amu = 931.5 MeV

Q1. Attempt any **two:---**

(i) What do you understand by the term transmission probability? Obtain an expression for the transmission probability of the α-particle through a rectangular barrier. **10**

(ii) Discuss the salient features of beta decay spectrum. How continuous nature of beta ray spectrum leads to the violation of laws of conservation of energy and momentum. Explain how the paradox was resolved. **10**

(iii) State Geiger-Nuttal law. Explain the origin of short range and long range α particles using energy level diagram. **10**

Q2 Attempt any **two:---**

(i) What are nuclear isomers? Discuss the nuclear isomerism of bromine. **10**

(ii) Discuss the contribution of different energy terms to binding energy and obtain Weizsacher's semi-empirical mass formula. Draw a neat diagram indicating the variation of contribution of different energy terms to the binding energy per nucleon with respect to mass number A. **10**

(iii) Discuss Mossbauer effect with experimental setup. State the importance of Mossbauer spectroscopy. **10**

Q3 Attempt any **two:---**

(i) Explain Breeder reactor? What are its advantages? **10**

(ii) What is natural fusion? Explain energy productions in stars using carbon cycle. **10**

(iii) Why are accelerators required in Nuclear Physics? Describe the Van De Graff generator. **10**

Q4 Attempt any **two:---**

(i) Describe the four types of elementary particle interactions. **10**

(ii) (a) Summarize the important experimental properties of the deuteron. **10**
(b) Write the basic properties of neutron, neutrinos and their anti particles.

(iii) Explain meson theory of nuclear Force. Using Heisenberg's uncertainty principle, estimate the mass of meson. **10**
(Given: range of the potential is 10^{-15} m, ħ = 1.054571 x 10^{-34} J.s)

Q5. Attempt any **four:**---(5 marks each) **20**

(i) Compute the kinetic energy of alpha particles emitted from $_{92}U^{232}$ nucleus. The atomic mass of $_{92}U^{232}$, $_{90}Th^{228}$ and alpha particle are 232.1095 amu, 228.0998 amu and 4.0039 amu respectively. Comment on the answer obtained.
(Given: 1amu = 931 MeV).

(ii) $_3Li^7$ and $_4Be^7$ have atomic masses 7.016005 amu and 7.016929 amu. Which of them show β-activity and of what type? Calculate Q value for it. Atomic masses of Lithium and Beryllium respectively are: M ($_3Li^7$)=7.016005 amu, M($_4Be^7$)= 7.016929 amu.

(iii) For the isobaric families with A = 45 and A= 48, estimate the nuclear charge Z_0 for the most stable isobar in each case.
Given : a_a = 19 MeV, a_c = 0.60 MeV,
m_p = 1.007825 u, m_n = 1.008665 u
1 u = 931.5 MeV

(iv) What do you mean by mirror nuclei? Determine the mass difference between two mirror nuclei.

(v) Protons are accelerated in a 100 cm cyclotron. The oscillator frequency is 10 megacycles. Calculate the magnetic field needed and the maximum energy that can be given to the proton.
Given: = m_p= 1.67x10^{-27} Kg, q= 1.6x10^{-19} C

(vi) Calculate the amount of energy available if 60 gm of $_{92}U^{235}$ is completely fissioned.
Given: Energy per fission of U^{235} is 200.5 MeV.

(vii) Which of the following reactions can occur by conservation laws of elementary particles? If not, state the conservation principles violated by the others.
a) $\Lambda^0 \rightarrow \pi^+ + \pi^-$
b) $\pi^- + p \rightarrow n + \pi^0$
c) $\gamma \rightarrow e^+ + e^-$

(viii) Explain Yukawa potential.
